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Crop Production Research

1981 Annual Report

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FOREWORD

Crop Production

Research under Program Element 677, Crop Production Efficiency Research, includes research under 14 National Research Programs (NRP) in Crop Production and one Special Research Program (SRP).

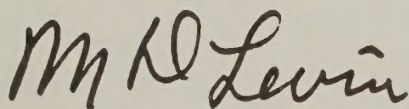
Research is conducted to improve plant productivity through improved varieties of food, feed, fiber, forage, florist and nursery crops, and turf; to develop new crop resources; and to develop improved crop production practices. Current emphasis is on research to develop new genetic stocks and varieties, increase yields and quality of crops, improve mechanization and crop production practices, and to alleviate the effects of adverse environmental conditions through hardier plants.

New multidisciplinary concepts for increasing our productive capacity have been initiated. Special emphasis has been placed on improving basic photosynthetic processes in plants, natural nitrogen-fixing processes in soils and plants, innovative cellular genetic research, better use efficiency of both renewable and nonrenewable energy resources, and control of plant growth and development.

The research workers in the plant sciences publish the results of their investigations in the open literature as quickly as sound judgment warrants. This is an administrative report to provide a brief overview of the scope of the activities and examples of recent findings to those interested in the results of this work. Some of these still have not been released by publication. No attempt is made at completeness.

This report outlines the production research for which the Crop Sciences Staff is responsible and provides a brief description of recent accomplishments at the various locations throughout the United States. The report is organized by National Research Programs, each of which describes a separate subject matter area. These ARS National Research Programs are subdivided into Technological Objectives which more specifically describe the objectives of each area of research.

Readers who have comments or inquiries are invited to contact either the National Program Staff or, more appropriately, scientists at the locations where the research is conducted.



M. D. LEVIN
Chief
Crop Sciences Staff

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SUMMARY

Crop production research is an integral part of the total research program conducted by the Agricultural Research Service. Research is conducted to improve plant productivity through improved varieties of food, feed, fiber, forage, florist, and nursery crops; to develop new crop resources; to better understand biological processes; and to develop improved crop production practices. Current emphasis is on research to preserve germplasm resources, to develop new genetic stocks and varieties, increase yields and quality of crops, improve crop production practices, and to alleviate the effects of adverse environmental conditions. There also is a new awareness of the need and opportunity to better understand the basic physiology of growth. New technology and recent advances in the use of plant growth regulators have opened new vistas for the more perceptive scientists. Such research will be particularly important as plants are recognized for the potential they have as one of the few renewable resources available to humans.

The research is described under 14 National Research Programs (NRP) and 1 Special Research Program (SRP).

A brief summary of each NRP and SRP is provided in the front of this volume. More detailed reports for each NRP and SRP follow with selected examples of progress and publication.

NRP 20010 Breeding and Production - Fruits, Nuts, and Speciality Crops

The objectives of this National Research Program are to develop new improved varieties for fruits, nuts, and specialty crops and to develop new improved cultural and management practices for these crops. This research is presently being conducted at 17 locations by 65 scientists in several disciplines and serves many small and diverse horticultural industries. Research reported in this annual summary is also reported in 75 separate scientific articles published in referenced journals. This current research includes highlights on (1) introduction of new improved pest-resistant scion varieties with increased yields, quality, consumer acceptance, and geographic adaptation; (2) introduction of new improved pest-resistant rootstock varieties with the potential for increasing yields, reducing the cost of production, and expanding areas of production; (3) use of intergeneric and interspecific hybridization in Citrus to introduce increased cold hardiness; (4) genetic studies on the inheritance and transmission of horticulturally important fruit and plant characteristics; (5) use of embryo culture in fruit breeding; (6) cryogenic preservation of pollen; (7) new techniques of indexing for viruses, discovery of new viruses, and testing for varietal susceptibility to viruses; (8) discovery of the causal agent of walnut blackline disease; (9) tissue culture and other methods of rapid plant propagation; (10) plant physiology studies on cold hardiness; (11) use of bioregulators to influence growth, flowering, and fruiting; and (12) cultural studies to increase yields and reduce the cost of production.

NRP 20020 Breeding and Production - Vegetables

This program emphasizes research in breeding and production of vegetables to develop new and improved genetic and cultural methods that will result in lowering costs of vegetables and potatoes to consumers and increasing efficiency of production of these crops to growers, small acreage farmers, and homeowners.

Good progress has been made toward the achievement of program goals through cooperative research efforts. A major program review was conducted in the Pacific Northwest area. The program was judged to be productive and strongly interactive with other program areas within USDA-ARS and with the States and industry. Major coordination of the potato breeding and disease research programs at Aberdeen and Prosser was achieved to provide leadership and service to the Western Region and enhance its contribution to the national program effort.

A total of 81 journal articles was published by research scientists in this program area indicating a high level of productivity. These publications, other reports, and releases of new cultivars and improved germplasm document the results of a wide array of research activity of 30 scientists at 16 locations in 13 States. Fundamental genetic research has led to the development and release of 11 new multiple disease-resistant cultivars and 14 germplasm or breeding lines. Most releases were conducted jointly with cooperating State agricultural experiment stations. New cultivars include seven crisphead lettuce types; three new distinctive russet potatoes; and a new *Cercospora* leaf spot-resistant southernpea for fresh market and home gardens. Noncommercial germplasm released includes three melon aphid-resistant, multiple disease-resistant muskmelon lines; two modified tendrill pea lines with reduced foliage and *Fusarium* resistance; one snapbean line with rust resistance and one with root-knot nematode resistance; one interspecific hybrid onion amphidiploid that has high vigor, disease resistance and winterhardiness; and six weevil-resistant sweet potato breeding lines.

Research on improving cultural practices has shown that ethaphon applications to tomato transplants before transplanting increased stem and root growth which should improve transplanting survival, plant growth, and ultimately increase fruit yield. Through research on dry bean quality, recommendations have been developed for quality maintenance during long-term storage. Sugars and major volatile compounds that contribute to carrot flavor have been identified, and assay procedures have been developed that now provide for efficient selection for carrot quality in a breeding program. Chickpeas (garbanzo) were shown to be exceptionally well adapted to Palouse conditions in the Pacific Northwest, gave yields that were at an economically high level, and would provide growers an alternate legume crop that is drought tolerant and energy efficient.

NRP 20030 Breeding and Production - Florist and Nursery Crops

The major emphasis of this program deals with the multidisciplinary research for development of new technology for improving productivity and increasing efficiency in the production of florist and nursery crops to enhance urban and rural environments. This need for new knowledge makes it essential to provide research results on selecting, improving, protecting, maintaining, and

cultivating plants for urban and rural home, landscape, and special purpose plantings such as parks, roadsides, and shopping centers.

In general, good progress has been made toward the achievement of program goals. Productivity of research scientists was high as measured by the publications of 58 journal articles. These publications and other reports document the results of a wide array of research activity within the national program, including the breeding and selection of new germplasm and cultivars; tissue culture propagation; basic and applied research on reaction and resistance to disease and insect attacks, and the development of effective pest control and management systems; improved cultural and management practices that increase yield, minimize losses, and improve quality; and study of factors contributing to environmental stress of plants, and enhancement of environmental quality by reducing pollution and improving human surroundings.

Specific research progress this year includes the release of seven new ornamental cultivars. These include two magnolias--Galaxy, a late flowering tree with improved red-purple color and wide adaptation, and Nimbus, a single or multiple stemmed upright tree with smooth gray bark and white, fragrant flowers; two viburnums--Chesapeake, a compact shrub with abundant flowering, dark green foliage and good autumn coloration, and Eskimo, a dwarf shrub with dense, dark green foliage and abundant flowering; Helene, a multistemmed, erect, densely branched Hibiscus syriacus shrub; Para Pink, a new bedding and hanging basket-type flowering plant of Torenia fournieri; and Amazon, a new type of container-grown ornamental of Chrysothemis pulchella.

Dr. John L. Creech, who served effectively as Director of the National Arboretum since 1973, retired and will be replaced by Dr. H. M. Cathey, currently Chief of the Florist and Nursery Crops Laboratory at Beltsville. Dr. F. S. Santamour served as Acting Director of the Arboretum and will continue as Research Leader. A strong research emphasis will be maintained at the Arboretum to complement and support the increasingly important educational and service activities.

Plans have been developed for the integration of an EPA laboratory facility into the USDA-ARS Ornamental Plants Research Laboratory at Corvallis, Oregon. The two facilities are contiguous, and the amalgamation of both personnel and facilities is expected to strengthen significantly the total program, and strongly contribute to increased activity in the IR-4 Minor Use Pesticide research and evaluation program.

NRP 20040 Breeding and Production - Corn, Sorghum, and Millets

Corn inbred lines released by the cooperative USDA-State programs are widely used in commercial corn hybrids. In a recent survey, it was determined that three inbred lines--B73, Mo17, A632--were each used in production of more than 100,000 pounds of hybrid seed. Wide use of a limited number of inbred lines causes concern in relation to genetic vulnerability.

Considerable attention during 1980 was given to a search for tolerance or resistance to Aspergillus flavus, the fungus which parasitizes corn and under some conditions produces aflatoxin. Possible sources of tolerance or resistance are under intensive study.

Long-term recurrent selection programs with maize are underway in an effort to improve new corn inbred lines, and consequently hybrids, for several quantitative traits, including yield, grain protein, protein quality, disease resistance, and insect resistance.

During 1980, 16 new inbred lines of sorghum, three of Pearl millet, and two corn germplasm lines were released from USDA-State Agricultural Experiment Station cooperative programs for use by public agency and private industry breeders or other research workers. This new germplasm makes available increased resistance to diseases and insects, earlier maturity, better lodging resistance, new sources of cytoplasmic sterility, photoperiod insensitivity, and other needed improvements.

NRP 20050 Breeding and Production - Small Grains

Primary emphasis is placed on basic and applied research directed toward improvement of varieties of wheat, oats, barley, and rice so that new varieties will produce more grain per acre, will have more effective protection from diseases and insects, will be able to withstand environmental adversities, and will produce better quality and more nutritious grain for food and feed.

In 1980, wheat was harvested on 70,853,000 acres, oats on 8,640 acres, barley on 7,233 acres, and rice on 3,925,000 acres. Rye was harvested from an additional 644,000 acres and very small acreages of triticale, wild rice, and buckwheat were produced. All are included in NRP 20050.

During 1980, 9 wheat, 1 barley, 2 oat, and 2 rice varieties were released cooperatively by SEA/AR and State Agricultural Experiment Stations. In addition, 18 wheat, 1 barley, and 2 buckwheat germplasm populations or lines were released for use by breeders.

Important progress was made in 1980 in many facets of research, one of which was disease resistance. Unique properties of the virus that causes soilborne mosaic in wheat were determined, more information was obtained on bacterial biocontrol of the wheat root-invading fungus that causes "Take-all," data on loss in yield resulting from soilborne pathogens on wheat were obtained, and the causal agent involved with bacterial kernel blight of barley was discovered. Considerable testing of wheat lines for tolerance to Barley Yellow Dwarf Virus was conducted, and further testing of the new source of resistance to the same virus in barley, transferred from ryegrass, was studied. The critical assignment for SEA/AR to screen breeding lines of wheat, barley, oats, and rice for appropriate quality factors was again fulfilled. Tens of thousands of lines were analyzed in our Quality Laboratories and results were sent to the breeders, both State and Federal, and in a few cases, to private industry. One of our laboratories is involved in a cooperative experiment with the Human Nutrition Laboratory at Grand Forks, North Dakota. Real progress was made in basic research involving freezing stress in wheat and barley, and in freezing test technology in oats and barley. Very promising advanced semidwarf oat lines are in the testing stage. These are but a few highlights of research conducted on small grains during 1980. The future holds both promise and excitement for improvement of these food and feed crops.

NRP 20060 Breeding and Production - Cotton

The mission is to develop new knowledge which will increase cotton production efficiency, expand exports, and provide consumers with a stable supply of fiber and food at a reasonable cost. Research approaches emphasize genetic improvement and the development of more efficient cultural and management practices that conserve energy, soil, and water. The research is conducted at 13 locations and involves about 39 scientists.

Accomplishments this past year include:

- o Cooperative release of 21 breeding stocks that provide new or improved genetic sources of resistance to insects, tolerance to heat and drought stress, favored fiber and seed properties, and adaptation to shorter season production systems.
- o Description of a cost-effective technique for artificially infesting large number of field plots with budworms in order to accelerate screening for resistance.
- o Description of improved instrumentation and technology for measuring quality parameters of small (individual plant) fiber samples.
- o Expansion of current knowledge on the role of nitrogen nutrition and hormonal activity in regulating the growth of the cotton plant under water stress.
- o Refinement of production systems that integrate plant spacing, water and nitrogen use, pest management, and application of plant growth regulators to optimize net profits.
- o Pioneering research on the biological control of seedling diseases with a fungus.

Research results were reported in 73 separate scientific articles, including a major review of integrated developmental events in cotton bolls.

NRP 20080 Breeding and Production - Soybeans, Peanuts, and Other Oilseed Crops

Primary emphasis is placed on the improvement of soybean, peanut, sunflower, flax, safflower, and guar by genetics and breeding and by cultural and management practices. Approximately 32, 8, 8, and 4 SY's are assigned to soybean, peanut, sunflower, and other oilseeds, respectively. Soybean, peanut, sunflower, and other oilseeds production research is conducted at 11, 3, 4, and 4 locations, respectively; the total number of locations for oilseeds production research is 16. Most of the research is highly cooperative with State Agricultural Experiment Stations and utilizes the disciplines of plant genetics, agronomy, plant pathology, plant physiology, microbiology, chemistry, entomology, and soil science.

Highlights of 1980 included: 1) Cooperative releases of seven soybean varieties and a germplasm line, improved for such characteristics as high yield, lodging resistance, disease and nematode resistances, and habit of growth;

2) cooperative releases of an early-maturing, large-seeded Spanish type peanut, an oilseed sunflower restorer line with multiple disease resistance, and three nonoilseed sunflower cytoplasmic male sterile lines and their maintainer lines; 3) identification of soybean germplasm with tolerances to excessive boron and excessive manganese, resistances to budblight and soybean mosaic viruses, and with a low level of lipoxygenase; 4) development of soybean germplasm with a lower level of linolenic acid; 5) identification of peanut germplasm with resistance to *Cylindrocladium* black rot disease; 6) identification of six *Rhizobium japonicum* strains with genetic exchange ability; 7) expansion of the sunflower species collection to 1695 accessions, including all species and subspecies of *Helianthus* native to the United States; 8) development of seedling test techniques for screening for resistance to the soybean diseases stem canker, phytophthora rot, and brown stem rot; 9) identification of a minimum of seven different structural genes specifying glycinin subunits of storage proteins in soybean seed; and 10) identification of a new race of downy mildew that is pathogenic on all previously resistant commercial sunflower genotypes. Program changes included increased emphasis on theoretical and quantitative inheritance of soybeans at Raleigh, North Carolina, as the State plans to emphasize applied soybean breeding. Soybean variety development was excluded at Columbia, Missouri, and emphasis placed on basic genetics and interorganismal genetics (gene-for-gene relationships) with soybean cyst nematodes. Guar research was reduced to strain testing at two locations, and the breeder was reassigned to full-time effort on sunflower at Bushland, Texas. The oilseeds production research program at Davis, California, will concentrate on sunflower cytogenetics (appointment of the cytogeneticist is pending).

NRP 20090 Breeding and Production - Sugar Crops

Primary emphasis in the program is on the improvement of sugar crops through breeding of superior cultivars of sugarcane and sweet sorghum and development of improved sugarbeet breeding lines. Secondary emphasis is on developing cultural and management practices to increase sucrose and sirup yields, minimize production losses, improve quality attributes, and efficiently conserve scarce resources in production systems involving the three crops. This research is conducted at 10 locations by 34 scientists. Sugarcane is grown on about 275,000 hectares in 4 states, and sugarbeets are grown on 480,000 hectares in 16 states. During the period 1976-80, domestic production of sucrose provided an average of 40 percent of U.S. consumption of caloric sweeteners on a per capita basis.

The highlights of 1980 include: (1) development of sugarbeet breeding lines with resistance for such characters as *Fusarium* stalk blight and nematodes; (2) cooperative release of a "soil-free" sugarbeet breeding line; (3) development of a breeding method to reduce the time required to produce male-sterile-equivalent sugarbeet lines; (4) evaluation of sugar crops for alcohol production; (5) cooperative release of three sugarcane cultivars; (6) development of two disease-resistant sweet sorghum cultivars; (7) a major discovery in beet western yellows virus etiology; (8) role of plant hormones (IAA and ABA) in controlling sucrose translocation; and (9) development of a laboratory method to reduce exposure to potentially toxic lead salts.

NRP 20100 Breeding and Production - Forage Crops for Hay, Pastures and Other Uses, Including Turf

Forage crops are gaining importance because of their role in reducing the need for nitrogen fertilizer, reducing the demand for grains in the production of quality beef and dairy products, and their contribution in reducing soil erosion and enhancing the Nation's water supplies. The program is directed toward improvement of the forage plants through basic genetics, plant breeding, plant physiology, and management. Research efforts are interdisciplinary, and Federal and State scientists cooperate to assure effective coordination of a national program on forage improvement and utilization.

Increased emphasis will be placed on improving forage quality, enhanced nitrogen fixation in clover and alfalfa, interspecific hybridization to introduce new sources of pest resistance, and fundamental studies of plant-animal interactions. Some highlights of 1980 are: (1) Perennial and annual alfalfa were crossed successfully for the first time; (2) An endophytic fungus has been shown to be associated with an alkaloid-causing fescue toxicosis; (3) Cold-tolerant buffelgrass germplasm has been found; and (4) One new cultivar and 15 germplasm lines have been released.

NRP 20110 Improved Vegetation and Management Practices for Range

Range, as with pasture and forages, has been increasing in importance in the past few years. Multiple use is an important, distinct aspect of range which produces unique challenges for scientists. Thus, the SEA-AR national research effort is directed toward improving the livestock production capacity of the range while maintaining and enhancing environmental quality and complementing other uses. Research emphasizes fundamental plant processes and their relation to environment and ultimately to the development of integrated range management systems. Limited availability of water will become increasingly important and provide unique research challenges as economic and ecologic forces move agriculture from intensive to extensive production systems. New technology will provide the basis for responses to environmental questions and for use by public and private rangeland managers.

NRP 20160 Introduction, Classification, Maintenance, Evaluation, and Documentation of Plant Germplasm

This is a three-pronged program: plant germplasm, new crops, and control of narcotics crops. The grouping is a natural one; all three programs draw heavily upon the botanical disciplines of taxonomy, ecology, and plant geography because they all deal with the occurrence and distribution of diversity among plants on a systematic, ecological, and geographical basis. The plants under study are mostly non-cultivated, or are being evaluated for their potential of useful diversity to established crops.

People that several years ago did not know what germplasm was, or did not care, are, across the land in universities, professional societies, back-to-nature movements, and in Congress, speaking out in concerned tones that this renewable but irreplaceable, resource be given the national priority that it merits. The Director, Science and Education, was apprised of the National Plant Germplasm System's needs and commissioned a review of it for the purpose of defining its strengths and weaknesses in organization, management, policy development and

implementation, planning functions, and utilization of resources. The study has been completed as has one by the General Accounting Office. These have brought forth a strong commitment within S&E to provide support needed to give this country the National Plant Germplasm System it must have to assure continuing high productivity of its crops.

Studies are underway to determine opportunities and methods for manipulating the biosynthesis mechanisms in narcotic plants leading to the elaboration of morphine and other phenanthrine alkaloids, cannabinoids, and cocaine. Through bioinduction these biosynthetic processes may be blocked or altered without killing the target plants or having adverse impact on other elements of the environment where such illicit crops are being produced.

The research under this NRP is being conducted at 26 locations in the United States and abroad, involves about 55 SY's, and is supported by approximately \$8.0 million.

NRP 20170 Physiological and Biochemical Technology to Improve Crop Production

This National Research Program coordinates and manages research elucidating the basic function of plants at the physiological and biochemical level. New data resulting from this research are used to establish advanced agricultural technology with emphases on field and horticultural crops.

Major fields of consequences within this National Research Program are: (1) improvement of photosynthetic capability, photosynthetic efficiency; translocation, metabolism, and biological conversion of solar energy of plants; (2) development of improved efficiency of nitrogen fixation and the absorption, translocation, and utilization of nutrients; (3) improvement of crop production under environmental stress and reduction of stress damage to plants; and (4) improvement of technologies for understanding water relations, seed germination, growth regulation, flowering, fruiting, and photoperiod as a base for using molecular biology to increase crop production efficiency.

There are 15 locations represented by 68 SY's engaged in research under this National Research Program. Research teams comprised of not only these scientists and their colleagues but scientists with expertise crossing many and varied National Research Programs work in concert, focusing on the optimal transfer of basic information to field application.

The highlights of the 1980 research include: divalent cation effects on Photosystem II reaction elucidated; potential reduction in photorespiration; site of chilling injury identified; discovery of a new N₂-fixing system; identification of nonnodulating genotypes of alfalfa; development of molecular probes for plant viroids; characterization of iron reduction mechanism; promotion of plant growth by brassinosteroids; cryostorage of crop germplasm; new plant growth inhibitors of unique chemical structure; reduction of tomato yields with mixtures of sulfur dioxide and ozone.

NRP 20180 Crop Pollination and Honey Production

About 210,000 people keep more than 4.3 million honey bee colonies in the United States. Each year these beekeepers produce over 200 million pounds

of honey, worth about \$100 million. The management of leafcutter bees adds another viable multimillion dollar agribusiness devoted to alfalfa seed production. More than 90 agricultural crops in the United States depend upon bees for pollination or are benefited to some extent by bee pollination. In essence achievement of the goals of this NRP may help provide an adequate supply of agricultural products at reasonable prices, improve the nutrition and way of life of all Americans, and benefit the Nation's balance of payments by identifying and solving problems associated with the maintenance and use of honey bee and other pollinators of important U.S. crops.

Recent studies show that production of hybrid cottonseed with honey bees as pollen vectors is technologically feasible. A non-Apis bee, Osmia lignaria, has pollinated small apple/pear orchards effectively in Utah. With increased efforts we can determine the pollination requirements of such crops as hybrid cotton, hybrid sunflower, hybrid onion, and alfalfa. The value of fruits, nuts, vegetable seeds, legume seeds, oilseeds, and vegetables pollinated by bees, plus the value of the crops and products derived from bee-pollinated seed crops, exceeds \$20 billion a year. These monetary values do not reflect the inestimable benefits, both aesthetic and productive, that people realize from their home gardens. Nor do they reflect the role that insect-pollinated plants play in providing food and cover to the birds and wildlife that grace our urban and rural landscapes.

As agricultural practices change, methods used to manage honey bees must change. Clean cultivation and monoculture have had an impact on beekeeping by removing the natural progression of nectar- and pollen-producing plants. Agricultural crops that rely on bee pollination must depend on an industry that is mainly oriented to production of honey. Managing bees for honey production must be a profitable business. Research must address many problems, including those associated with substitute diets for bees, chemical control of bee behavior, mechanization of colony management and movement, and specialized management techniques.

Insecticides used to protect agricultural crops from harmful insects frequently kill large numbers of bees. Expanded research on all aspects of the "pesticide/bee" interaction is needed to reduce bee losses. This resource of pollinators must be protected. Residues of methomyl have been detected in combs one year after honey bees had visited fields sprayed with the insecticide. Package bees installed on these combs have died in large numbers. Innovative methods must be developed to reduce pesticide hazards to bees. Research in this area has effectively identified problems; future work must address solutions.

Honey bees and non-Apis bees are subject to infection, infestation, or depredation by many disease organisms and invertebrate or vertebrate pests. Current studies have shown that Terramycin does not pose a residue problem if used properly and that a Bacillus thuringiensis formulation protects stored, unused combs from the damage caused by the Greater Wax Moth. Additional chemotherapeutic and management methods must be identified and used to restrict the distribution and incidence of these diseases. An internal bee mite, Acarapis woodi, has been found by AR researchers in samples of bees collected in Mexico, which is the first report of the mite on the North American continent. It highlights the need for a national diagnostic and control center to maintain the surveillance necessary to prevent the introduction and spread of new, exotic diseases and pests. It is predicted that the mites may reach the U.S. border by the end of this decade.

The beekeeping industry may soon use a lactalbumin-yeast pollen substitute diet that has been developed at the Bioenvironmental Bee Laboratory in Beltsville.

The Africanized honey bee with its aggressive trait and propensity to swarm and abscond is approaching Panama. A honey bee breeding program that develops and maintains gentler bees and the technology to cope with or modify the behavior of the Africanized bee is required immediately. Such a program may improve the performance of bees, make beekeeping more efficient, and reduce the costs of honey production and of keeping bees for crop pollination. The consumer ultimately benefits from more abundant and less expensive food.

NRP 20190 Improved Methods and Equipment for Production of Field,
Horticultural, and Fiber Crops

Equipment and methods are under development aimed at solving long-standing and difficult problems in the culture, harvesting, and farm handling of a variety of horticultural and field crops. Greatest emphasis continues to be on new or improved mechanisms which reduce the cost of production through reducing labor requirements, reducing the cost of machinery, or reducing crop losses. This development work also frequently requires research on the physical properties of plants and plant materials, and on plant cultural practices. Engineers work in cooperation with plant breeders, plant physiologists, plant pathologists, and specialists in food processing and marketing to plan as well as to execute this work. The research is conducted at 14 locations in 12 States in both Federal and State stations where work is usually done through an interdisciplinary team.

Substantial progress was made this year in reducing labor requirements for harvest of citrus, apples, peppers, leafy vegetables, and peanuts. Further progress was made toward reducing machine costs for cotton and nursery crops.

Progress was also made this year in possible methods of saving energy through reducing tillage operations and cultural systems which use multiple cropping and relay cropping as a means of improving soil conservation while also increasing total economic returns.

National Research Program 20010

BREEDING AND PRODUCTION - FRUITS, NUTS, AND SPECIALTY CROPS

This National Research Program involves research on breeding and production of fruits, nuts, and specialty crops which will result in increased production efficiency for commercial growers, part-time farmers, and home-owners and increased availability, variety, and quality of fruits, and nuts for the consumer. Where possible, this research is conducted by multidisciplinary teams comprised of horticulturists, geneticists, physiologists, and pathologists in association with entomologists, nematologists, agricultural engineers, and marketing specialists. The research is national or regional in scope and concentrates on long-range projects not easily initiated or justified by individual State agricultural experiment stations.

Technological Objective 1: Develop new and improved varieties of fruits, nuts, and specialty crops that combine improved yield potentials; quality characteristics; better resistance to pests; tolerance to environmental stress; and adaptation for mechanical culture, harvesting, and handling.

NPS Contact: Howard J. Brooks

Research Locations:

Fresno, California
Indio, California
Orlando, Florida
Byron, Georgia
Beltsville, Maryland
Poplarville, Mississippi
Chatsworth, New Jersey
Wooster, Ohio
Corvallis, Oregon
Brownwood, Texas
Kearneysville, West Virginia

Examples of Recent Progress:

Progress made in breeding improved grape varieties - Fresno, California.
Grape crosses made in 1979 produced 7,493 new seedlings which were planted in the field. This year, 211,549 emasculations resulted in 15,949 seeds from 106 controlled crosses. Thirty-one new selections were made in 1980. Three additional table grape selections will be placed in grower trials. Twenty-seven selections were dried for raisins and seven appeared promising. One selection, B44-2, has consistently appeared outstanding for 3 years and will be placed in grower trials. It ripens 1 month earlier than Thompson Seedless.

Grape rootstocks screened for nematode resistance - Fresno, California.

About 350 selections have been made from the original 8,000 seedlings from 200 rootstock crosses which were screened for resistance to Meloidogyne incognita, M. javanica, and M. arenaria nematodes. This screening program will identify parents which later will be used to develop improved rootstocks. Thirty-eight nematode-resistant selections have the desired rooting characteristics.

Seedless grape embryos successively cultured in artificial media - Fresno, California. Plants were obtained from abortive ovules of two seedless grape varieties by using in ovulo culture techniques. In another experiment, a plant was obtained from an ovule excised only 15 days after anthesis. A modified medium appears promising for culturing excised embryos of early-ripening grapes which have very poor seed germination when planted in soil. This technique will allow breeders to use seedless grape varieties as parents in their breeding programs.

Progress continues in developing improved stone fruit varieties - Fresno, California. Approximately 5,520 peach and nectarine, 2,000 plum, and 1,560 apricot seedlings were planted in the field. This year, 74 peach and nectarine, 40 plum, and 42 apricot controlled crosses were made resulting in 4,300 peach and nectarine, 2,100 plum, and 1,800 apricot seeds. An additional 8,130 peach and nectarine embryos were cultured on defined media from which 4,360 plants are now growing and will be transplanted to the field. Nineteen peach, 32 nectarine, 5 plum, and 3 apricot seedlings were selected for the first time and saved for further evaluation. Fourteen peach, 5 nectarine, 6 plum, and 4 apricot selections are being tested commercially as potential new varieties. Of these selections, 13 peach and 2 nectarines were developed through embryo culture and are very early maturing. The Blackamber plum variety was released and over 100,000 trees have been budded by nursery workers.

Embryo culture technique developed for early ripening peaches - Fresno, California. During in vitro culture, peach embryos 1 to 3 mm long respond the most to sucrose and the least to growth regulators and organic addendum. Ovules containing embryos as small as 0.5 mm were successfully cultured. Preliminary tests to determine optimum sucrose level, temperature, culture vessel, and time in culture have been completed for ovule culture. It appears that a simplified technique can be used to grow immature Prunus embryos.

Testing of citrus scion and rootstock varieties continues - Indio, California. Testing of rootstocks under commercial scions continues in nine field trials. Seed and budwood or promising rootstocks were supplied to cooperators. Several citrus rootstocks tolerant to gummosis and tristeza virus have been identified. Use of these rootstocks should enable economic citrus production in areas where one or both of these diseases limit or prohibit use of standard rootstocks. Fruit quality studies were made on commercial scion varieties in the rootstock trials. Scions include lemon, orange, and tangelo on a total of about 50 rootstocks. The methods used are those employed in comparable work at the University of California, Riverside. Citrus breeders from the Orlando station have reviewed the

Indio citrus collections. Seeds for repropagation of about 30 clones were sent to Orlando.

Research initiated to develop deciduous citrus cultivars - Orlando, Florida. Breeding experiments have been initiated to determine whether the deciduous characteristics of Poncirus trifoliata can be transferred to nondeciduous Citrus. Suitable test progenies will be made by utilizing backcrossing, sib and modified sib crossing techniques to approach this objective. It is also planned to utilize severe cold stress sites as well as artificial freeze tests to speed up the detection and selection process with this trait. Over 5,200 seeds resulted from crosses made in 1980. The winter deciduous character of P. trifoliata has been observed in certain P. trifoliata X mandarin and P. trifoliata X citrange hybrids and this has been verified under controlled conditions. Citrange, citrumelo, and Citrus selections do not express winter deciduousness as does P. trifoliata. A selection procedure under controlled conditions has been developed so that we can identify winter deciduousness in young hybrid seedlings.

Time of bud break being evaluated in citrus - Orlando, Florida. Citrus varieties and related species have been evaluated for spring flower and leaf bud-break characteristics. Poncirus trifoliata, Eremocitrus glauca, and Fortunella sp. had late spring leaf bud break similar to their citrus parents. Eremocitrus hybrids had spring leaf bud-break characteristics intermediate to their parents. Spring flower bud break was early and before leaf bud break on P. trifoliata, late on Fortunella sp., and on other varieties it followed leaf bud break by 7 to 14 days. Spring leaf bud break occurred later, in general, when the winter hardening temperatures were mild and earlier when temperatures were cool. Under controlled environments, leaf bud break of selected varieties was similar to the varieties under field conditions.

Radiation used to develop seedless citrus mutants - Orlando, Florida. Research was initiated to evaluate the effectiveness of irradiation in inducing seedlessness in citrus varieties with seedy fruits. Fruit on young trees propagated from seeds and budwood were examined. Among plants from irradiated seeds were 12 near-seedless types among 160 plants of Pineapple orange, three near-seedless Duncan grapefruit, and one near-seedless Foster grapefruit. Irradiated budwood of Foster gave seven near-seedless types among 106 plants.

Citrus interspecific and intergeneric hybridization - Orlando, Florida. Research is underway to broaden the genetic base of the citrus industry by transferring desirable traits from other genera and species to commercial scion varieties. The 1980 crossing effort produced 10,099 seeds derived from a wide range of interspecific and intergeneric hybrids based on F_1 , S_1 , modified S_1 , BC_1 , and complex F_1 X BC_1 combinations. Twenty-seven intergeneric hybrids derived from three species of Citrus, Eremocitrus, Fortunella, and Poncirus were propagated for planting in a severe cold stress area. This research will continue to be emphasized.

Citrus relatives used to develop new pest-resistant citrus rootstocks - Orlando, Florida. Crosses made in 1980 yielded 3,340 seeds and were derived from a wide range of complex interspecific and intergeneric hybrids. These crosses were designed to combine cold resistance and resistance to burrowing nematode, citrus nematode, Phytophthora, and tristeza in a single potential rootstock candidate. Twelve F₁ intergeneric hybrids of Poncirus trifoliata with three species of Citrus selected for potential in rootstock breeding were propagated for testing as base germplasm for breeding tristeza-resistant rootstocks.

Citrus hybrids found tolerant to tristeza virus - Orlando, Florida. Recent research indicates that citrus tristeza virus (CTV) resistance can be maintained in hybrids resulting from backcrosses to virus-tolerant parents. This resistance becomes highly significant for developing CTV-resistant scion varieties and overcoming CTV intolerance of some rootstocks such as sour orange. At the present time, most citrus grown in Florida is affected by the tristeza virus.

Two new peach varieties introduced - Byron, Georgia. In 1980, 2,676 peach seedlings fruited for the first time and were evaluated. About 235 seedlings were selected for further observation. Approximately 150 second-test selections were evaluated for their potential as varieties. Fourteen advanced selections were propagated and sent to other locations for tests. Two new varieties were introduced - Sunland and Starlite.

New nectarine introduced - Byron, Georgia. In 1980, 691 nectarine seedlings fruited for the first time and were evaluated. Approximately 233 seedlings were selected for further observation. Twenty-three second test nectarines were re-evaluated. The variety Durbin was released to the public. Four nectarine selections were sent to other locations for testing. With the several introductions made in the last few years, nectarines are now considered a commercial crop in the Southeastern States.

Progress continues in breeding apples for the Southeastern States - Byron, Georgia. In an effort to develop highly colored, early fruiting apple varieties adapted to the Coastal Plain of the Deep South, additional cross pollinations have been made. Eighteen apple selections adapted to the Coastal Plain were made and propagated. Testing of selections from the Byron and Blairsville projects and selections and varieties from other locations continued. Ozark Gold from Arkansas shows the most promise. Two irradiated mutant selections from Mollie's Delicious, Mutant 5, and 5-8K-30(b) were propagated for testing.

Two new plum varieties introduced - Byron, Georgia. Evaluations of seedlings for high quality and high adaptation to the Southeastern States continue. Ten new selections were added to the testing program. One selection, BY 68-971, has the same attributes as our new release Robusto and has been elevated to second-test status. The first plum variety to be released from this program, a beautiful amber-fleshed, full-season, purple Japanese-type plum, Explorer, was released. Notices have been sent out to interested

growers and propagators. The second plum to be released from this program, a highly productive, attractive, and disease-resistant Japanese-type hybrid plum, Robusto, was released in December.

Everbearing strawberries being increased for introduction - Beltsville, Maryland. Two new day-neutral strawberry selections, EB60 and EB62, are being increased for introduction. These selections combine cyclical fruiting through the growing season, resistance to soil and plant fungal pathogens, high plant vigor, and fruit quality. California strawberry varieties, selected for hill culture performance, yielded very well at Beltsville in matted rows and will serve as potential yield and size parents. With the combination of strawberry cold hardiness and red stele resistance, 45 promising clones were identified. An additional 5,100 screened red stele-resistant seedlings were sent to Wisconsin, New York, and Minnesota for field selection in cold environments. From 38 crosses, 30,000 strawberry seeds were sent to Poplarville, Mississippi, to be screened for resistance to the crown rot fungus.

New Junebearing strawberry variety released - Beltsville, Maryland. The new Junebearing variety, Scott, was introduced and quickly accepted by the public. Selection MD-US 4429, another late midseason berry with improved size and yield, was distributed to cooperating nursery workers for increase before release. From 21 crosses made in 1980 in the continuing red stele-resistant variety development program, 47,155 seeds were produced. Resistant seedlings from the greenhouse screening benches, totaling 5,559, were established in field plantings. A replicated selection test involving seven advanced selections and two standard varieties was also established. A replicated field study of 25 red stele-resistant progenies indicated some shifts in vigor of recombined inbreds compared with a standard outcross in the field relative to their performance in the greenhouse as very young seedlings.

Promising blueberry selections made - Beltsville, Maryland. In a continuation of cooperative research with North Carolina, 2,360 blueberry seedlings were sent to North Carolina during the last year. Approximately 20 new blueberry selections were made. Blueberry selections NC 1688, 1524, and 1525 are among the most promising candidates for new varieties. Other promising selections are NC 1518, 1523, 1408, 1409, 1440, 1836, 1837, 1412, 1512, 1074, 1514, and 1476. Domestic exploration in the Carolinas was carried on this year to fill in voids in the Vaccinium species germplasm collection.

North American-European fruit germplasm inventory completed - Beltsville, Maryland. Data for the first combined North American-European fruit germplasm inventory have been collected and computerized. The inventory contains 45,000 entries and shows the location where the germplasm is being maintained.

Cooperative strawberry breeding program now fully developed - Poplarville, Mississippi. Fifty-nine strawberry crosses were obtained from cooperating SAES and ARS locations. Seed from these crosses was germinated at Poplarville and 25,000 seedlings were grown in the greenhouse under controlled conditions. These seedlings were inoculated with five strains of Colletotrichum fragariae isolated by cooperating scientists of SAES and screened for anthracnose resistance. Resistant seedlings were shipped to cooperating scientists (4,000 to North Carolina, 600 to Florida, and 1,500 to Louisiana). Three hundred seedlings were planted at Poplarville. Twenty-two clones from the 1977 strawberry seedling field at Poplarville were selected for further evaluation. The selections were based on their high resistance to anthracnose, fruit flavor, size, color, firmness, yield, plant growth habit, and vigor.

Extensive blueberry plantings established - Poplarville, Mississippi. Thirty-four hundred blueberry seedlings from crosses made at Beltsville, Maryland; Poplarville, Mississippi; and Gainesville, Florida, were planted during the year. Thirteen selections made at Poplarville in previous years were sent to Hammond, Louisiana, for evaluation. Naturally established Vaccinium ashei and V. elliotti were collected and propagated. A collection of old selections from native habitats was arranged from Tifton, Georgia, and seeds of V. darrowii were obtained from Gainesville. One V. ashei clone apparently native to south Mississippi, was located. This genetic material will be evaluated for use as parents in the breeding program.

Blueberry plantings established for disease resistance studies - Chatsworth, New Jersey. Seedling progeny from 206 blueberry crosses were examined for red ringspot disease. Crosses with Vaccinium ashei or V. amoenum included in their parentage produced the greatest number of red ringspot-resistant seedlings. Approximately 5,075 new seedlings were planted in the field for evaluation toward development of blueberry cultivars with consistent high yield and quality. About 5,900 seedlings in greenhouse flats will be set in the field in 1981. Over 300 seedlings from previous plantings were selected for further evaluation.

Promising pear selections identified - Wooster, Ohio. Approximately 1,200 pear seedlings representing 32 progenies were planted at Wooster during the last year. Approximately 9,342 seed were obtained from 31,000 emasculations and pollinations. US 56111-65, a pollen-sterile selection, fruited for the first time at Wooster. The fruit is large, green in color, low in grit, and outstanding for flavor. No fire blight has been recorded for this selection. This selection will be propagated and distributed for further testing. Eight psylla-resistant seedlings were selected. Seedling 72751-11 shows promise as a new selection. Fabraea leaf spot data were taken on all trees at Wooster.

Superior walnut introduced from Spain - Corvallis, Oregon. Ennis and Butler, two new filbert varieties, were officially introduced to the industry in 1980. Ennis is a large-sized nut and a productive tree designed to replace Barcelona, the current main crop variety. Butler is a high-yielding pollenizer designed to replace Daviana, the currently popular pollenizer. Approximately 580 self-rooted rootstocks were produced from 46 different clonal selections. Each of these trees will be top-worked with Ennis and distributed to cooperating growers for future performance evaluation. Seeds of potential Persian walnut rootstocks were obtained from Spain, France, California, and Oregon. Scionwood of the Badajoz walnut was received from Spain in October. Attempts will be made to establish this superior selection in the United States.

Machine-harvested strawberry tested - Corvallis, Oregon. Progress has been made in the program to develop strawberry varieties that may be machine-harvested and machine-capped. 1980 yield and processing tests show that OR-US 4681 has potential for introduction for the Pacific Northwest processing industry. It averages 75 percent for machine capping and 3 to 4 tons of usable fruit per acre. New selections OR-US 645-4 and 645-5 are superior in firmness to all varieties except Linn.

Machine harvestable raspberries tested - Corvallis, Oregon. Research continues on the objective to develop self-supporting, primocane-fruiting red raspberries that produce machine-harvestable fruit in August. Two new selections (OR-US 2033 and 2036) have had processing tests and the product is equal to the leading processed variety Willamette. Both are being propagated for more extensive testing. OR-US 2047 was promising for local hand harvest but too soft for machine harvest.

New high alpha-acid hop line being commercially tested - Corvallis, Oregon. Ten years of small plot testing of a new high alpha-acids hop variety were completed and commercial testing has begun at four sites of 1 to 20 acres located in Washington and Oregon. This variety, USDA-21193, has good yields and produces nearly double the alpha-acids per acre of the most widely grown commercial variety Cluster. Because the brewing industry uses hops in proportion to their alpha-acids content, good commercial evaluation and release of this line represent a significant advance in production efficiency.

Improved aroma hop selections look promising - Corvallis, Oregon. Forty-three aroma selections from the Cascade hop progeny grown for the first mature year in a seedless location were machine-harvested in 1980. Yields ranged from excellent to poor. Alpha acid content generally was higher than 7 percent and in some cases higher than 10 percent. Co-humulone content ranged from the low 20's to the low 30's. Several selections with low co-humulone content, good yield potential, and an alpha:beta ratio similar to known European aroma cultivars, look promising. Storage trials of these selections are currently in progress.

Long-term storage of hop pollen appears feasible - Corvallis, Oregon.

Pollen of four male hop genotypes, stored for 1 year in liquid nitrogen at a temperature of -196⁰F, was comparable in fertility to fresh pollen. Moisture content of pollen samples at the time of freezing should be about 10 to 12 percent; otherwise, freeze damage and clumping render the pollen useless. Long-term liquid nitrogen storage of hop pollen apparently is feasible.

Improved peppermint germplasm developed - Corvallis, Oregon. *Mentha acquatica*, *M. citrata*, and *M. gentilis* were identified as the most promising germplasm to exploit for developing mints with lavenderlike odors.

Genotypes of these species and intra- and interspecific crosses between these and other *Mentha* species yield plants with varying concentrations of linalool and linalyl acetate in their oils. Progeny populations from these species show much variation in plant morphology, disease resistance, and yield. Thirty-three selections from hybrids and genotypes of these species were established in an isolated plot for the beginning of a restrictive recurrent selection breeding program to develop superior mints with lavenderlike odors. The selections represent plants resistant to rust, tolerant to verticillium wilt, and with yields up to three times that of standard varieties. The first seeds from the breeding block were collected in 1980.

Potential established for improving menthol type mints - Corvallis, Oregon.

Thirty-eight selections for *Mentha arvensis*, *M. piperita*, *M. cardiaca* and hybrids between these and other species were established in an isolated plot for the beginning of a restrictive recurrent selection breeding program to develop superior, high menthos type mints. Plant characteristics considered in selecting the 38 plants were chemical profile of the oils, disease resistance, and yield potential. Menthol content of the oils ranged from a trace to 83 percent, yield ranged from 0.7 to 2.7 percent of dry plant weight, and rust resistance ranged from susceptible to immune. With such a range of characteristics in existence, there appears to be a tremendous potential for developing improved menthol-type mints.

Pear breeding plots now established at Kearneysville - Kearneysville, West Virginia. Researchers continue to develop improved pear varieties with high fruit quality and increased resistance to fire blight, leaf spot, and pear psylla. Seventy-six accessions were planted in the species collection and 136 genotypes were added to the germplasm plantings.

A planting of major varieties and "elite" USDA selections and releases was established with 7 genotypes. The second test planting was enlarged by 18 selections. A total of 2,400 seedlings was planted. Nursery inoculation with the fire blight organism eliminated 37 percent of the 1979 seedlings, whereas greenhouse inoculation of the 1980 seedlings eliminated 59 percent. Approximately 150 fruit samples from seedlings, selections, and varieties were picked at the Beltsville orchards and evaluated.

New disease-resistant peach introduced - Kearneysville, West Virginia. Approximately 3,000 peach and nectarine seedlings from 1979 crosses have been planted at Kearneysville. These include hybridizations between high quality by brown-rot resistant selections and cold hardy by high quality selections. Over 5,000 peach and nectarine seeds from 1980 hybridizations of high quality, stem pitting, and brown rot-resistant trees are under stratification for 1981 spring planting. Sentry, an early-maturing peach selection, was named and released. The fruits are large and attractive, the trees are productive, and this new variety is resistant to bacterial spot disease.

Compactness of peach trees found to be caused by a dominant gene - Kearneysville, West Virginia. Over 200 peach seedlings of 1979 crosses of dwarf by semi-dwarf and standard types have been planted for future evaluation of tree size and fruit quality. Seed of 1980 crosses between high quality and compact and dwarf selections have been stratified for spring 1981 planting. Progeny of 1977 crosses of Empress dwarf by Compact Redhaven compact tree type and open pollinated Compact Redhaven have been evaluated on the basis of growth habit. Preliminary data indicate that compact growth habit and dwarfism are controlled by separate gene systems. Compactness is a dominant genotype and dwarfism is recessive.

Technological Objective 2: Develop new and improved cultural and management practices for fruits, nuts, and specialty crops that increase yield, minimize production losses, improve quality, and conserve use of natural resources.

Research Locations:

Booneville, Arkansas
Davis, California
Indio, California
Orlando, Florida
Byron, Georgia
Beltsville, Maryland
Poplarville, Mississippi
Stoneville, Mississippi
Chatsworth, New Jersey
Corvallis, Oregon
Brownwood, Texas
Weslaco, Texas
Prosser, Washington
Wenatchee, Washington
Kearneysville, West Virginia

Extensive grape collection re-indexed for viruses - Davis, California. Indexing of grapes was initiated, continued, or completed on selections or explant lines obtained from grape breeding programs at Davis and Fresno, California, and Geneva, New York, as well as from various donors in Argentina, Bolivia, Canada, Chile, France, Germany, Israel, Japan, Mexico, Spain, and Switzerland. Approximately 249 heat-treated explants from 94 cultivars and selections were established for indexing or observation. All of the 625 accessions in the Foundation Vineyard at Davis were re-indexed on virus indicators so that any stem pitting-affected plants that might have been overlooked in earlier indexing could be eliminated. The method for detecting stem pitting was not demonstrated until 1976 and consequently, early accessions were not screened for this detectable symptom. Plans for the grape and tree fruit germplasm repository are complete and construction of facilities has started.

Corky bark grape virus on decline in California - Davis, California. There is apparent spread of corky bark virus in grapes in Mexico, but in California no indication of spread was observed. In fact, the incidence of corky bark is declining in California since growers have been planting virus-free stocks. The disease is becoming difficult to find in California, especially in vineyards planted since 1970.

Pierce's disease of grape transmitted from weeds by insects - Davis, California. Pierce's disease, an extremely bad grape bacterial disease, was detected in weed hosts in California by use of the ELISA technique. The weeds miner's lettuce, wild strawberry, Vinca major, and blackberries were found to harbor the bacteria. The bacteria were also identified in crushed infectious leafhoppers. Samples of four individual insects crushed at a single time proved to be a convenient index for determining whether insect populations were carrying the disease. With this technique, Pierce's disease was identified in the northern Sacramento River Valley, at many locations around San Francisco Bay, and in the Delta of the Sacramento and San Joaquin rivers in areas far removed from grape cultivation. Pierce's disease was also detected in spittle bugs at the mouth of the Russian River and in green sharpshooters at Half Moon Bay.

Tolerance to Pierce's disease identified in commercial grape varieties - Davis, California. The relative sensitivity of 25 common grape varieties to Pierce's disease was determined by inoculating young plants in the greenhouse with a pure culture of the bacterium and by following the subsequent development of the bacterial population with sensitive serological techniques. Chenin Blanc proved to be the most tolerant vinifera variety tested; a number of others showed some degree of tolerance. This finding permits advisory personnel to recommend tolerant varieties in areas where sensitive grapes are killed by the disease. With the selection of the proper variety, Pierce's disease should become a minor problem in California.

Walnut rootstocks show varying resistance to Phytophthora fungi - Davis, California. Research has shown that nine different Phytophthora spp. are commonly associated with declining or dead walnut trees. P. cactorum is the most widely distributed, whereas P. cinnamomi and P. citricola are the most destructive among nine Phytophthora spp. Studies showed that several sources of Paradox rootstock are significantly more resistant than Juglans hindsii walnut rootstock to various isolates of P. cactorum. Thus, use of Paradox rootstock offers an effective control for crown rot caused by P. cactorum. Paradox and J. hindsii, however, were equally and highly susceptible to both P. cinnamomi and P. citricola. Contrary to the assumption in the literature that English seedling rootstock is more resistant to Phytophthora crown rot, studies showed that several selections of English seedlings and J. hindsii were highly susceptible to isolates of P. cactorum, P. citricola, P. cinnamomi, and P. cryptogea. J. hindsii, however, was more resistant than Manregian or Capatean rootstocks to P. megasperma.

Walnut blackline now proven to be caused by the cherry leafroll virus - Davis, California. Since 1924, it has been assumed that walnut blackline is a noninfectious incompatibility between scion and rootstock disorder. However, research has now shown that blackline of walnut is a specific infectious virus disease. A virus was consistently isolated from blackline-affected trees. The virus was purified and has now been identified as a strain of the cherry leafroll virus. One-year-old English black walnut trees, when mechanically inoculated with purified virus from orchard blackline-affected trees, developed blackline at the graft union. Thus it has been proved experimentally that blackline disease is caused by a strain of the cherry leafroll virus. This finding is extremely important for prevention of further spread of the disease by infected English seedling rootstocks. Preliminary results also indicated that English walnut seedlings are adversely affected by blackline virus. Experiments have been established to determine the relative resistance of 16 walnut varieties to blackline when propagated on black walnut, Paradox, and Eureka English seedling rootstocks.

Walnut blackline virus transmitted by pollen - Davis, California. It has been determined that the causal virus of walnut blackline is commonly present in pollen, seed, and seedling progenies of English walnut trees from commercial orchards. In the past, pollen has been collected indiscriminately and used for pollinization of commercial orchards from aircrafts. The seed also has been collected indiscriminately and used for propagation of walnut trees. This discovery is very important for prevention of the introduction of this economically important disease into healthy commercial orchards.

New assay technique used for fruit virus detection - Davis, California.
Radioactively labeled immunosorbent assay (RISA) has been developed for the rapid and reliable infection of various strains of tomato ringspot virus (TomRSV) in stone fruits. RISA was two times more efficient than ELISA and eight times more efficient than mechanical transmission in the detection of TomRSV in stone fruit trees. Furthermore, the detection and identification tasks can be accomplished with RISA within 2 days and with graft or mechanical transmission techniques would require over 6 months. These new findings will contribute significantly to proper identification and control of several diseases in stone fruit trees caused by TomRSV.

In vitro propagation of date palm successful - Indio, California.
Plantlets derived from date palm tissue cultures have been successfully grown in the greenhouse. An electrophoresis examination of tissue-cultured plantlets for variation of isozymes of gene-enzyme systems did not reveal any genotypical differences between the parent palm and the plantlets derived from it. Tissue cultures of date palm callus were subjected to liquid nitrogen temperatures for up to 3 months. Thawed cultures regenerated plantlets which eventually were transferred to free-living greenhouse conditions. Coupling tissue culture propagation with cryogenics could preserve fruit tree germplasm without the use of conventional field plantings and their maintenance. Development of technology in the field of cryostorage of germplasm will result in saving valuable germplasm at nominal expense.

Diagnostic techniques being developed for citrus blight disorder - Orlando, Florida. The extraction and isolation of the zinc-containing compounds in blight-affected citrus tissue have yielded a ninhydrin-positive compound. This compound is in both phloem and xylem tissue and may be the cause of the accumulation of zinc in the tissues during the onset of the disorder. A study of the accumulation of $^{65}\text{ZnCl}$ in blight-affected plants grafted to healthy tissue demonstrated that the Zn accumulation potential can be transmitted from blight-affected tissues. In the search for an early diagnosis technique for citrus blight, an immunological assay is under development. The titer of the rabbit-sera is high enough to allow cross specificity reaction tests which are now in progress. The first experiments show a positive response to chloroform:methanol extracts. A reduction in carbonic anhydrase activity is associated with the onset of blight.

New systemic fungicide approved for use on citrus - Orlando, Florida.
Metalaxyl (Ridomil), a systemic fungicide, has been shown to be an excellent fungicide to control citrus root and foot rot in seedbeds, nurseries, and young tree replants. This research was the basis for a temporary label for use on nonbearing citrus in Florida. Metalaxyl is superior to methyl bromide or ethylene dibromide soil fumigants in being less hazardous and having less effect on existing beneficial soil fungi.

Soil nutrients' ratios change under citrus trees affected with blight - Orlando, Florida. Research efforts to correlate leaf and soil nutrient levels with citrus blight are continuing. Analysis of water extracts of soil samples collected in 1977 and 1978 under blight-affected and healthy trees showed no significant differences in extractable potassium, calcium, magnesium, or sodium, but did show lower sulfate and chloride levels under blighted than under healthy trees. The cation/anion ratio of soil under blight trees was significantly higher than of soil under healthy trees.

Leaf protein content and cold hardening of citrus studied - Orlando, Florida. During the conduct of citrus cold hardiness research on synthesis of proteins, it was found that neither cold hardening nor moment of freeze injury at different temperatures caused major alterations in protein banding on acrylamide gels. Researchers concluded that protein changes in acrylamide gel patterns were the result of, and not the cause of, lethal freeze injury in Valencia orange leaves. The major band on the gels occurred at R_f 10-11 which suggested a high molecular weight protein and comprised at least 50 percent of the soluble proteins found in the orange leaves.

Fusarium toxins cause necrosis in citrus leaves - Orlando, Florida. The physical status of citrus leaves from plants inoculated with *Fusarium solani* was studied. Wilted leaves had a relatively lower calculated water content and a higher indicated water potential than turgid leaves from healthy plants. Electrical conductivity of leachates of healthy and diseased leaves did not differ significantly. However, diffusive resistance of leaves showing early wilt was markedly higher than the resistance measured on healthy leaves. Dilute ethanolic extracts of *F. solani* toxin (naphthazarins) caused necrosis in leaf tissue when the extract was streaked on leaves.

Tristeza virus affects incidence of root rots in citrus - Orlando, Florida. An endomycorrhizal virus experiment was conducted on citrus trees in the greenhouse. Mycorrhizal sour orange inoculated with the T-3 strain of tristeza developed shock symptoms and restricted growth parameters almost as severely as nonmycorrhizal virus-infected seedlings. Compared with nonvirus mycorrhizal seedlings, virus-infected seedlings, mycorrhizal or not, developed noticeable root rot and reduced fungus sporulation in soil from the mycorrhizal plants. The T-1 strain of tristeza had no effect on growth of mycorrhizal plants, but root rot increased and fungus infection decreased.

Sucrose may play role in citrus cold hardening process - Orlando, Florida. Research continues on the protective effect of different substances against freeze stresses in citrus tissues. Sucrose feeding was more effective than proline feeding through freshly cut-ends of citrus leaves and stems in increasing freeze tolerance. Feeding sucrose under greenhouse conditions approximated freeze tolerance acquired with low temperature cold hardening. Concentration of 0.5 M sucrose increased both the sugar and

starch concentrations but not the proline concentration in citrus leaves. Dilute concentrations of proline decreased total sugars, whereas starch remained about the same and proline markedly increased. Data suggest sucrose plays a larger role than proline in citrus cold hardening.

Peaches from irrigated orchards keep longer in storage - Byron, Georgia. A peach storage study indicated no difference in weight loss or quality of nonirrigated vs irrigated fruit after 3 weeks' storage at 30°C and 3 days at 23°C. After 4 weeks' storage at 30°C and 3 days at room temperature, nonirrigated peaches lost more weight but developed less wooliness than did irrigated peaches. Quality was acceptable from both treatments after 3 weeks' storage but was not acceptable from either treatment after 4 weeks' storage.

Disease identified for phony peach disease - Byron, Georgia. Research on the phony peach disease has been hampered by not knowing the causal organism and not being able to culture the organism. Now the phony disease bacterium has been found to be the same organism as that causing plum leaf scald. The bacterium has been successfully cultured on a medium formulated for the Legionnaires' Disease bacterium, Legionella pneumophila. Modifications of basic components and media pH improved growth rate.

Georgia peach orchards found to have high incidence of virus - Byron, Georgia. Surveys of six Georgia orchards were completed in which peach tree decline was correlated with positive Prunus necrotic ringspot virus assays based on two methods - the Shirofugen bioassay and the ELISA test. Over 60 percent of trees in decline had Prunus necrotic ringspot virus, and the virus was present in 28 percent of symptomless trees in the same orchards. Healthy orchards had little, if any, ringspot.

Powdery mildew disease decreases oil and protein content in pecans - Byron, Georgia. Powdery mildew was found to decrease the free fatty acid content of pecan kernels from 126 percent to 0.7 percent. Moisture content was found to increase from 30 percent to 33 percent, percent oil decreased from 37 to 33.5, and percent protein dropped from 8.5 to 6.5.

Blueberries unresponsive to Mycorrhiza inoculation - Beltsville, Maryland. Adaptation studies of blueberries to mineral soils were carried out in the greenhouse. Rabbit-eye blueberries take up more divalent and less monovalent ions, but the reverse was found with highbush blueberries. Seedlings were selected from progenies on the basis of adaptation to mineral soils. Root respiration studies of blueberry crosses were initiated. Pure rabbit-eye blueberries had half the root respiration of other crosses. This may have implications in the adaptation to climatic and soil stresses of the rabbit-eye species. Mycorrhiza inoculation, fertilizer levels, and soil porosity were studied in sand culture-grown highbush blueberries. Blueberries did best on native blueberry soils at high fertility. Mycorrhizal infection was not important.

Plastic mulches increase everbearing strawberry production - Beltsville, Maryland. First harvest yield was significantly improved in plantings of everbearing strawberry EB 62 by increasing average midday soil temperatures by 50C with plastic mulches at the 3-inch depth. This effect was lost by late summer because of very high soil temperatures. Over 7 tons per acre were harvested from the best plots between July 18 and October 18 after strawberries were planted in May of the same year. Fertilization above normal rates of nitrogen decreased yields.

Tissue-cultured strawberry plants more productive than standard nursery plants - Beltsville, Maryland. Tissue culture-propagated plants of Earliglow, Redchief, and Guardian strawberries produced more runners, had more flowers, and yielded more berries and total fruit weight than did greenhouse runner plants of the same varieties in a replicated field trial. Runner plants had larger fruit size on first and second picking, thus reducing somewhat the yield advantage of the tissue-cultured plants. A very small proportion of detrimental off types were isolated in the tissue-cultured plants.

Blackberry and strawberry trials show potential for these crops in Mississippi - Poplarville, Mississippi. A thornless blackberry variety test was established at Poplarville. Third-year data from erect thorny blackberry variety studies indicated Brazos and Cheyenne were the highest producers. Pruning to ground height immediately after harvest in 1979 did not reduce 1980 plant yields except in Brazos. Fourteen virus-free strawberry varieties were tested for fruit yield, size, and quality plus disease resistance. Planting dates and systems were also compared. Florida 90 was the leading variety, yielding 15,000 pounds of fruit per acre. Early fall planting with a double-row system resulted in the highest yields.

Fungicide combinations effective against cranberry fruit diseases - Chatsworth, New Jersey. Research continues on the effect of fungicides on cranberry fruit rot control, berry color, and yield. Chlorothalonil gave the best control of cranberry fruit rot. Color development and yield were not adversely affected. Captafol gave good control against *Sporonema oxycocci*, but it was not as effective against *Physalospora vaccinii* as the other fungicides tested. *Guignardia* and *Physalospora* caused most of the fruit rot. A combination of zinc ion-maneb complex and captafol controlled fruit rot significantly better than captafol alone.

New mycoplasma-like disease found in black raspberries - Corvallis, Oregon. Several Munger black raspberry fields in Oregon were found to contain plants showing witches-broom and stunting. Infected plants die and whole fields have been plowed out as a result. Electron microscopy of infected Munger revealed the existence of mycoplasma-like bodies. This is the first report of a mycoplasma-like organism in black raspberries in the United States. Although no witches-broom symptoms were found in red raspberries, the possibility exists that Munger witches-broom disease is the same or similar to European *Rubus* stunt disease.

Small fruit varieties surveyed for susceptibility to viruses - Corvallis, Oregon. Research continues on the susceptibility and rate of infection of the major Pacific Northwest small fruit varieties to tomato ringspot virus (TomRSV) infection. In field plot tests with naturally viruliferous dagger nematodes, none of 12 Rubus varieties were infected with TomRSV after 1 year. One of 25 strawberry varieties being retested under similar conditions became infected. In greenhouse tests with TomRSV-transmitting dagger nematodes, two of ten strawberry varieties and one of five OR-US strawberry selections became infected after 60 days. Although greenhouse testing for TomRSV immunity can now be done in flats of infested soil, the variability inherent in the test at present will require considerable replication to reach desired levels of reliability.

Two new diseases found on bramble fruits in Oregon - Corvallis, Oregon. Additional tests of major Pacific Northwest blackberry varieties for graft-transmissible viruses were established in field plantings. A previously unreported premature senescence disease of summer red raspberry was found to be graft-transmissible, detectable in black raspberry test plants, and to be associated with a rod-like particle as seen in thin tissue sections by electron microscopy. A sterility condition of Darrow blackberry was found to be associated with a graft-transmissible agent causing foliar symptoms on Alpine strawberry.

Rubus and blueberry varieties indexed for viruses - Corvallis, Oregon. Heat-treated, shoot-apex tissue-cultured clones of four Rubus varieties have been developed and are now being maintained, increased, and horticulturally evaluated for eventual public release. Fourteen U. S. Rubus selections have been similarly indexed, and two were found to be virus infected. Four of the 14 have been successfully heat-treated, tissue culture-propagated and are now being grown out for horticultural evaluation. A collection of virus tested clones of the major U. S. highbush blueberry varieties has been initiated with Dr. A. Stretch, ARS, Chatsworth, New Jersey, and Dr. D. Ramsdell of Michigan State University. All 10 varieties tested negative by ELISA for tomato ringspot virus, tobacco ringspot virus, blueberry shoestring virus, and blueberry leaf mottle virus. All clones require additional graft indexing on Cabot, and additional varieties must be added to establish a basic indexed collection for the use of State departments of agriculture in developing modern blueberry certification programs in the United States.

Filbert production increased by high density plantings - Corvallis, Oregon. Filbert trees spaced 6, 8, 10, and 12 feet apart in 18-foot rows yielded 2,990, 3,156, 2,816, and 2,706 pounds of filberts per acre, respectively. At 12 years of age, trees at all spacings have grown together so yield differences are no longer statistically significant; however, trees at the closer spacings continue to perform well. Trees were pruned on alternate years to remove 10, 20, and 30 percent of their wood to influence the alternate bearing habit. Trees pruned in the "on" year (1980) exhibited 0.5, 19, and 30 percent yield reduction, respectively, when compared with those pruned in the "off" year (1979).

Cluster size associated with alternate bearing of filberts - Corvallis, Oregon. The bearing habit of the Barcelona variety was analyzed by determining the set of small, medium, and larger sized stem flower cluster buds. It was found that 75 percent of the nuts borne occurred on large flower clusters. Large flower clusters only occurred on vigorous wood. Vigorous wood occurs during a light crop year. The potential for reducing the biennial yield fluctuation lies in varieties that tend to bear nuts on small flower clusters as well as large ones.

Hot-callusing device greatly improves filbert propagation - Corvallis, Oregon. A device for hot-callusing graft unions was designed, constructed, and successfully used with filbert trees. Five experiments from January to April 1981 involving over 200 grafts yielded an average of 89 percent success compared with 7 percent for control trees. A public use patent is being sought for the device.

Quality factors for crops associated with oil content - Corvallis, Oregon. All possible correlations were run between 12 different quality measurements of female hop plants. Most significant were those related to oil content: there was a positive correlation with alpha-acids, beta-acids, lupulin content, and storage stability. These data indicate that in new lines there will be a tendency for high-alpha lines to have high oil and among those with high oil there will be a tendency toward poor storage. Although highly significant, the correlation values are low enough to assure that high alpha, low oil, and good storage characteristics can be combined.

Pecan scab data help growers in Texas reduce fungicide sprays on pecans - Brownwood, Texas. Scab readings were taken on a large number of pecan varieties in Texas. These readings and data from four previous years have been put into a form suitable for keypunching to form a computer data file. This information will be used to identify sources of scab resistance for the breeding program, advise growers on the relative scab resistance of varieties, and monitor development of scab races. A fungicidal spray schedule based on tree phenology and hours of leaf wetness saves four applications over a conventional spray schedule but still gave equally good control of scab.

Improved cold tolerance of citrus obtained with plant bioregulators - Weslaco, Texas. Citrus seedlings sprayed with 36 combinations of Mepiquat chloride, a plant bioregulator plus surfactant, resulted in improved cold protection. Cold protection with chemicals is an inexpensive way of protecting citrus trees thus minimizing production losses to growers after severe freezes. This possible use of bioregulators would have considerable potential in the Rio Grande Valley in Texas.

New hop selections have potential reduce hop imports and expand hop exports - Corvallis, Oregon. Three advanced hop selections which have received brewer acceptance in pilot test brews were increased and established in large scale field plots to provide brewers with sufficient product to evaluate hops for possible new varieties. Because U. S. brewers presently import 12 million pounds of aroma hops, the commercial release of new varieties has the potential to greatly reduce our imports and increase our exports to over 30 million pounds.

Rate of nitrogen applications associated with winter hardiness of pear trees - Wenatchee, Washington. Research continues on the relationship of essential mineral elements and carbohydrates to hardiness of fruit trees. Anjou pear trees were more hardy with a dormant application of 1/3 pound of nitrogen than the 1 pound of nitrogen rate of the 1/2 and 1 pound of nitrogen applied during the late summer. There was a tendency for greater hardiness of Anjou trees treated with summer sprays of calcium chloride. In some cases, carbohydrates influenced cold hardiness, but more information is needed to establish possible trends.

Alfalfa greening disorder of Anjou pears associated with cultural practices - Wenatchee, Washington. There was additional evidence gained during the past year that indicates that the alfalfa greening disorder of Anjou pears may be caused by a deficiency in levels of calcium in the peel of the affected fruit, excessive irrigation, high rates of nitrogen fertilizer, severe pruning, or possibly a virus. Not all experiments involved with nitrogen fertilizers, foliar sprays, pruning methods, irrigation levels, weed control, and bud transmissions had conclusive results.

New chemical shows promise for controlling vegetative growth in apples - Wenatchee, Washington. A new chemical, PP 333, is very effective in controlling vegetative growth of apples without affecting fruit size or quality. The chemical is most effective when applied to the ground under the trees. A rate of 40 g of 50 percent active material per 100 square feet controls 90 percent of vegetative growth. It is thought that this treatment will be effective for two seasons. Advantages of the treatment are no dormant pruning, more flowering, higher yields, stronger spurs, increased fruit color, less fertilizer, less herbicide (because grass growth is also controlled), and less mildew (chemical is also a mildewcide). The chemical has a broad action spectrum, and similar growth control is expected on all tree fruits.

New chemical affects apical dominance of apple trees - Wenatchee, Washington. Aminoethoxyvinylglycine (AVD) effectively increases fruit set on Delicious, Golden Delicious, and Granny Smith apples, and Anjou pear varieties when applied at a concentration from 50 to 100 ppm applied 2 weeks after full bloom. The main effect is reduction of ethylene production which reduces the amount of June drop. A fall application of AVG on apple trees reduces ethylene production in the dormant buds and completely removes apical dominance in the tree. The result is a 40 to 50 percent increase in vegetation growth on all parts of the tree which also increases total leaf surface. AVG, applied 2 weeks after bloom, increased fruit set of Anjou pears but decreased size with increasing concentration.

New chemical effective in treating dead spur-affected apple trees - Wenatchee, Washington. The 1,260 apple trees in the dead spur plots were reinoculated with spurs from five inoculum sources. Ten cultivars were top-worked on 370 trees in five orchards in four locations. Heat-treated Red Delicious varieties were planted in the field. Granny Smith and dead spur-affected Golden Delicious were heat treated and lined out in the nursery. Aminoethoxyvinylglycine (AVD) was successful in treating dead

spur-affected trees. In AVG-treated trees, not only did fewer weak spurs die but also many "dead" spurs resumed growth. The results of the survey suggest that the dead spur disorder in Delicious is transmissible and may be related to the "leggy" growth in other varieties.

Fruit training systems established - Kearneysville, West Virginia.

A replicated tree training block of nine apple varieties was planted to evaluate three training systems with over-the-row harvesters. A tatura trellis with five peach varieties was established and training was initiated. Small-branched trees hampered training to the trellis. Summer pruning studies on mature Golden Delicious resulted in significant increases in light levels within the tree interior. Shearing vs. hand-heading produced similar growth responses. Dormant pruning time on summer-pruned trees was significantly reduced over unpruned trees.

Plant growth regulators show significant responses on apple trees -

Kearneysville, West Virginia. Results of preliminary greenhouse trials on apple seedlings with plant growth regulators produced significant growth control responses. Chemical PP 333 was the most effective in controlling growth. Leaf tissue on PP 333-treated plants indicated improved nitrogen levels. Field applications of PP 333 as a foliar spray on mature standard Delicious trees reduced terminal growth significantly over untreated trees. Multiple applications gave significantly greater response than did single applications. Extensive field studies with Promalin, 6-BA, and Alar chemicals indicated 6-BA had exceptional branch-initiating capabilities. On bearing trees, use of 6-BA resulted in a significant reduction in fruit set but fruits were larger and had a more typical appearance.

Effect of cold temperatures on apple tissues studied - Kearneysville,

West Virginia. Present studies have demonstrated that when apple twig tissues are exposed to a lethal cold temperature there is a large increase in the evolution of ethane and a decline in the evolution of ethylene. The increase in ethane production is an indication of membrane lipid disruption and subsequent lipid peroxidation. Preliminary experiments have demonstrated an increase in ethane evolution during the first hour following freezing. This suggests that membrane disruption is one of the primary consequences of freezing injury in apple.

New method developed for making epidermal sections and imprints of plant

surfaces - Kearneysville, West Virginia. A simple, inexpensive method has been developed for making epidermal sections and imprints of plant surfaces. The procedure involves the attachment of plant surfaces to microscope slides with cyanoacrylate adhesives (super glue). After 3 minutes, the unattached tissue is removed leaving a permanent microscopic preparation of the glued surface on the slide. Such preparations are superior to those prepared by epidermal stripping and imprint procedures. They can be made inexpensively in the field or in poorly equipped laboratories. Application may be found in studies of stomatal behavior, plant "finger printing," and the infection process by microorganisms.

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National Research Program 20020

BREEDING AND PRODUCTION - VEGETABLES

This National Research Program involves research in breeding and production of vegetables to develop new and improved genetic and cultural methods that will result in lowering costs of vegetables and potatoes to consumers and increasing efficiency of production of these crops to growers, small acreage farmers, and homeowners. Geneticists, plant pathologists, entomologists, plant physiologists, and horticulturists (both Federal and State) work in a team approach to evaluate and improve vegetables and vegetable cultural methods.

The research is conducted at 16 locations in 13 States in both Federal and State stations where USDA/ARS scientists usually work as a team with State scientists.

In 1980, vegetables and potatoes (including dry beans and peas) were harvested from 6.2 M acres with an aggregate value of over \$6 billion.

Technological Objective 1: New and improved genetic populations, breeding lines and cultivars of vegetables that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling.

NPS Contact: A. E. Thompson

Research Locations:

Palmer, Alaska
Brawley, California
Salinas, California
Tifton, Georgia
Aberdeen, Idaho
Orono, Maine
Presque Isle, Maine
Beltsville, Maryland

East Lansing, Michigan
Corvallis, Oregon
Mayaguez, Puerto Rico
Charleston, South Carolina
Weslaco, Texas
Prosser, Washington
Pullman, Washington
Madison, Wisconsin

Examples of Recent Progress:

Two new potato cultivars named - Palmer, Alaska. Potato clone AK34-2 was named Highlat Russet and released to the public in April, 1980. Highlat Russet is a multipurpose, russet type adapted for culture at high latitudes. Potato clone AK14-1 is the best scab-resistant, white-skinned potato noted in 30 years of potato cultivar trials in Alaska. Release of this clone, to be named Alasclear for its very clear, white skin, is scheduled early in 1981.

Resistance to sclerotinia drop of lettuce identified - Salinas, California. Lettuce breeding lines and cultivars showing varying levels of resistance to sclerotinia drop have been identified in greenhouse and field tests. Differences and relative standings have been consistent in both types of trials. These materials will provide the basis for breeding drop resistant, adapted, high quality cultivars. Drop resistance will increase yield and quality and therefore increase growers profit at reduced cost to consumers.

Aphid resistant muskmelon breeding lines released - Salinas, California. AR5, AR Topmark, and AR Hale's Best Jumbo muskmelon (cantaloupe) breeding lines were released to seed workers and plant breeders. These lines are less damaged by aphids and aphid-vectored viruses than susceptible types in greenhouse and field trials, and will serve as sources of aphid resistance and high quality for breeding new cultivars and F₁ hybrids. Resistance should significantly reduce muskmelon yield losses due to aphids and aphid-vectored viruses.

New potato cultivars increase productivity in the West - Aberdeen, Idaho. Potato cultivars released from this project over the last 6 years are grown on significant commercial acreage in 4 western states plus North Dakota, and Alberta, Canada. In 1980, seed production of Lemhi Russet, Butte, and Targhee is enough to plant approximately 10,000 acres of commercial potatoes while maintaining existing seed acreages. These cultivars are the major alternatives to Russet Burbank in the multipurpose fresh pack and processing industry of the irrigated West. They return a higher yield of U.S. No. 1 tubers to the grower, and in the case of Lemhi Russet, higher internal quality.

Release of potato cultivar Russette - Beltsville, Maryland; Presque Isle and Orono Maine. Russette has an oblong to long russet tuber. It is more widely adapted than BelRus and has higher yield potential because of its later maturity. Commercial production and market acceptability have been demonstrated from Maine to Florida and Michigan.

New potato cultivars increasing in popularity - Beltsville, Maryland; Presque Isle and Orono, Maine. Belchip and BelRus, new potato cultivars developed and released in 1978 for the Northeast and Atlantic Coast areas, are rapidly increasing in popularity. Demand in the Northeast and Canada far exceeds seed supply for both cultivars. BelRus now ranks fourth among 43 cultivars grown for certified seed production in Maine.

Mildew-resistant Fordhook lima bean - Beltsville, Maryland. A green-seed Fordhook lima bean developed and produced at BARC has combined resistance to all known races of downy mildew. Downy mildew is the most serious disease of lima beans in the mid-Atlantic production area. This new line will be released to breeders and seed companies as MRF 79 early in 1981.

New processing tomato hybrid US 68 developed - Beltsville, Maryland. The tomato hybrid widely tested for 3 years as 77B68 will be named US 68 and released early in 1981. Results of university, processor, and grower trials have demonstrated that this line is earlier than any presently available processing cultivar for the Eastern U.S. It yields well, is widely adapted, can be mechanically harvested, and has excellent fruit quality for canning whole or product manufacture. It is the first F₁ tomato hybrid that has the potential of becoming a leading processing cultivar in the Eastern United States.

Release of amphidiploid onion germplasm ga-c 76 - Beltsville, Maryland.

Onion germplasm ga-c 76 was produced by colchicine treatment of the sterile interspecific hybrid between the common onion and mildew-resistant Allium galanthum, a wild species of Western Siberia and Central Asia. The primary features include high vigor, disease resistance, and winterhardiness. This new germplasm should make valuable contributions to onion breeding programs of Federal, State, and private industry.

Development of multiple disease-resistant beans for the tropics - Mayaguez, Puerto Rico. Multiple disease-resistant breeding lines of the cultivated bean (Phaseolus vulgaris) have been developed from an interspecific cross of the cultivated bean and the Scarlet Runner bean, Phaseolus coccineus. Breeding line XR-235-1-1, which will be released jointly by ARS and the Puerto Rico and Florida Agricultural Experiment Stations, exhibits uniformly high resistance to all known strains of common bacterial blight (Xanthomonas spp.) and to root rots, especially ashy stem blight (Macrophomina phaseolina). Federal and State research cooperators in Michigan, Wisconsin, Washington, New Jersey, Florida, and many areas in the tropics have received advanced lines from this program and are finding the high vigor and disease resistance extremely useful in their breeding programs.

Colossus-80, a new disease-resistant southernpea - Charleston, South Carolina. Colossus-80 was developed to replace Colossus, a widely-adapted and popular home garden and fresh market cultivar that is highly susceptible to Cercospora leaf spot. Colossus-80 is a large-podded, large-seeded, brown crowder type that is virtually indistinguishable from Colossus. Colossus-80, however, has a high level of resistance to Cercospora leaf spot, and it is not subject to the severe yield reductions that this disease is frequently responsible for in Colossus plantings. Additionally, Colossus-80 has a much greater tendency to produce a second crop than Colossus, which, even in the absence of disease, tends to defoliate and die immediately after harvest.

New high quality, multidisease-resistant muskmelons - Charleston, South Carolina. New muskmelon lines have been developed that combine high levels of disease resistance with superior fruit quality. Under epiphytotic conditions for diseases, the plants remained nearly disease-free throughout the season. The fruit of these lines contained an average of 16.5% soluble solids which make them exceptionally sweet. These lines represent a significant step toward the release of multiple disease-resistant, high quality melon cultivars. A green-fleshed breeding line, C570, is expected to be released in 1981.

The first weevil-resistant sweet potato breeding lines released - Charleston, South Carolina. Six sweet potato breeding lines--W-71, W-115, W-119, W-125, W-149, and W-154--possessing moderate levels of resistance to the sweet potato weevil in combination with resistances to other soil insects and diseases were released in 1980. They have dark orange flesh, relatively high yields, and generally acceptable canning and baking qualities. These lines represent the first sources of weevil resistance available, and they provide valuable combinations of pest resistance for breeders worldwide. Line No. W-125 may become acceptable as a cultivar.

Wild tomato germplasm contributes to fruitworm resistance - Charleston, South Carolina. A wild tomato species, *Lycopersicon hirsutum*, has been identified as a source of resistance to the tomato fruitworm. *L. hirsutum* is readily cross-compatible with the commercial tomato, *L. esculentum*, and research results indicate that the resistance factor can be transferred into the tomato. Resistance is due to the presence of an antibiotic factor in the leaf tissue. Because the early instars of the fruitworm larvae depend on leaf tissue as a primary food source, any increase in the antibiotic effect of this tissue should increase resistance. Breeding procedures to transfer this resistance factor into the cultivated tomato are well underway.

Release of six unique new dry bean cultivars - Prosser, Washington. Five multiple disease-resistant, dry bean cultivars were released jointly with Washington, Idaho, Oregon, or Colorado. Included were the first Pinto type (NW-410 and NW-590) with significant combined Fusarium and mosaic resistance, the first Fusarium-resistant Red Mexican type (NW-59 and NW-63) with early-maturing short vines, and the first pea bean (NW-395) resistant to curly top. Another Pinto bean, 6R-354, developed at Prosser and outstanding in North Dakota tests, was chosen for joint release with North Dakota, an important Pinto bean-producing State. It will be named Pindak and released in 1981.

An improved method of breeding potatoes and tomatoes - Prosser, Washington. A new potato and tomato breeding method was developed involving concurrent mass intercrossing within and between groups of breeding lines selected for attributes such as yield and disease resistance. Because most attributes are controlled by several genes, scientists have found it difficult to accumulate all the genes for maximum expression of a given attribute, such as yield, while they are simultaneously selecting for 10 to 20 other important characteristics. Concurrent mass intercrossing has been combined with a newly developed method of mass screening in early generations for disease resistance, storability, processability, and horticultural performance to provide an efficient method of screening large plant populations to find those few genotypes superior to current cultivars.

Modified plant types of peas for improved harvestability - Prosser, Washington. Two pea breeding lines, 792022 and 792024, were released which are the first to combine modified tendrils with resistance to races 1 and 2 of Fusarium wilt and resistance to Fusarium root rot. Because of strong tendrils and reduced foliage, both lines should resist lodging and vine rot and dry more quickly for seed harvest.

Seedborne mosaic virus-resistant pea lines developed - Pullman, Washington. Eight pea lines were developed by using a procedure which essentially retained cultivar integrity while the gene for resistance to pea seedborne mosaic virus was being added. The resistant lines should form a first line of defense against the virus which is threatening the entire pea and lentil industry.

Chickpeas adapted to the Palouse region - Pullman, Washington. Chickpeas (garbanzo) were shown to be exceptionally well adapted to Palouse conditions and gave yields which were at an economically high level. The addition of the crop to the cropping sequences of the Pacific Northwest will provide

growers with an alternate legume crop which is drought tolerant and energy efficient. The nitrogen fixation capability of chickpeas should prove to be very beneficial to succeeding grain crops.

Methods developed to evaluate divergent germplasm for environmental stress - Pullman, Washington. Growth cabinets for intensive studies on a selected group of lentil genotypes and greenhouses for extensive studies on a large number of genotypes are being utilized to critically evaluate divergent germplasm for heat and drought tolerance. Photoperiodic response and other physiological processes responsible for flower, pod, and seed abortion under stressful conditions are being identified. New methodology will aid in the selection of parental material for hybridization and the rapid evaluation of superior stress-tolerant genotypes in early generations of segregating progeny.

Mild flavored storage onion developed - Madison, Wisconsin. A nonpungent onion hybrid with good storage quality and adapted to northern-producing areas will fill the need for a salad or sandwich onion that can compete with western Sweet Spanish and the Bermuda or Grano types from South Texas.

Improvement of culinary quality in carrot breeding lines - Madison, Wisconsin. Discovery that carrot inbreds with the best flavor generally transmit good taste in F_1 hybrids and also the development of an efficient laboratory assay for quality open the way for rapid improvement of quality with established parental inbreds. Identification of sugars and the major volatiles that contribute to carrot flavor along with improved laboratory procedures provide the basis for efficient selection for quality in the breeding program.

Multiple disease screening methods developed for cucumber seedlings - Madison, Wisconsin. More than 300,000 seedling plants were screened or indexed for resistance to all major cucumber diseases in 1980. Through the use of large-scale screening techniques, it has been possible to successfully combine resistance to eight diseases (scab, cucumber mosaic virus, powdery mildew, anthracnose, downy mildew, angular leaf spot, bacterial wilt, and target spot) with gynocious sex expression and other useful horticultural characteristics.

Use of Endosperm Balance Number (EBN) theory to break interspecific crossing barriers in potato - Madison, Wisconsin. The wild Mexican species Solanum cardiophyllum ($2n=2x=24$); the wild Argentine species S. commersonii ($2n=2x=24$); and the nontuber bearing species S. fernandezianum ($2n=2x=24$) and S. brevidens ($2n=2x=24$) were all determined to be 1EBN. S. cardiophyllum has been successfully hybridized with S. fernandezianum and with S. commersonii. A doubled clone of S. brevidens ($2n=4x=48$) has been successfully crossed with 2EBN S. chacoense ($2n=2x=24$). The 1EBN species listed have among them excellent frost resistance, high levels of resistance to several viral and fungal diseases, and good insect resistance. These species previously have been an inaccessible form of germplasm, primarily because of endosperm incompatibility. Because of utilization of the EBN hypothesis, this natural crossing barrier can now be broken with conventional means available to any potato improvement program. The theory has application to other crops based on work with corn and Datura and an analysis of crossing data from the literature.

Technological Objective 2: New and improved cultural and management practices that increase vegetable yields, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.

Research Locations:

Palmer, Alaska
Salinas, California
Tifton, Georgia
Beltsville, Maryland
East Lansing, Michigan
Corvallis, Oregon

Mayaguez, Puerto Rico
Charleston, South Carolina
Prosser, Washington
Pullman, Washington
Madison, Wisconsin

Examples of Recent Progress:

Ethephon increased stem and root growth of tomatoes after transplanting - Tifton, Georgia. Ethephon applied to tomato transplants of 20 processing cultivars at the rate of 300 ppm, 14 days before transplanting, increased the number of stem roots, length of stem roots, and length of stems and roots 10 days after transplanting. This cultural practice would aid in improving transplanting survival, improving growth after transplanting, and ultimately increasing fruit yield. Even though ethephon increased stem rooting in all 20 tomato cultivars, large differences in stem rooting were observed among cultivars.

Metalaxyl increased marketable pepper and tomato transplant yield and controlled downy mildew of cabbage - Tifton, Georgia. Metalaxyl applied at 1.12 kg/ha immediately after seeding increased marketable pepper and tomato transplant yield, increased weight of marketable pepper and cabbage transplants, decreased *Pythium aphanidermatum* disease loci in pepper, decreased soil *Pythium* spp., and decreased *Peronospora parasitica* (the cause of downy mildew) in cabbage. Metalaxyl has a potential use in the \$10 million Georgia vegetable transplant production industry when the chemical is approved for food crops.

Long-term storage conditions affect dry bean quality - East Lansing, Michigan. Storage of high moisture beans at high temperatures causes severe destruction of dry and processed bean quality. Bean discoloration, firm texture, and increased mold growth during storage are primary effects. Recommended optimum bean storage conditions are initial moisture content less than 14%, temperatures below 70°F, and relative humidity below 75%.

CULTIVARS RELEASED

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
Lettuce		
Alamo	ARS and CA AES	Crisphead type, adapted to California production districts
Anza	ARS and CA AES	" " " "
Laguna	ARS and CA AES	" " " "
Ramona	ARS and CA AES	" " " "
Rita	ARS and CA AES	" " " "
Vega	ARS and CA AES	" " " "
Vesta	ARS and CA AES	" " " "
Potato		
Highlat Russet	ARS and AK AES	Multipurpose russet adapted to high latitudes
Lemhi Russet	ARS, ID, OR, CA, WA, and ND AES	Widely adapted russet with high internal quality
Russette	ARS, FL and NJ AES	Multipurpose russet adapted to Northeastern United States and Florida
Southernpea		
Colossus-80	ARS and SC AES	Cercospora resistance
NONCOMMERCIAL GERMPLASM RELEASED		
Muskmelon (cantaloupe)		
AR Hales Best Jumbo	ARS and CA AES	Melon aphid resistance
AR Topmark	ARS and CA AES	Melon aphid resistance, sulfur tolerant
AR-5	ARS and CA AES	Melon aphid and powdery mildew resistance
Onion		
ga-c 76	ARS	Amphidiploid, vigorous, medium bulbing, winter hardy perennial

NONCOMMERCIAL GERMPLASM RELEASED

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
Pea		
792022 792024	ARS and WA AES	Fusarium resistance and modified tendrils
Snapbean		
BARC-Rust Resistant-1	ARS and WA AES	Rust resistance
B 4175	ARS	Root-knot nematode resistance
Sweet Potato		
W-71	ARS, SC and TX AES	Sweet potato weevil resistance
W-115	ARS, SC and TX AES	" " "
W-119	ARS, SC and TX AES	" " "
W-125	ARS, SC and TX AES	" " "
W-149	ARS, SC and TX AES	" " "
W-154	ARS, SC and TX AES	" " "

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National Research Program 20030

BREEDING AND PRODUCTION - FLORIST AND NURSERY CROPS

This National Research Program deals with multidisciplinary research to develop new technology for improving productivity and increasing efficiency in the production of florist and nursery crops to enhance urban and rural environments. This need for new knowledge makes it essential to provide research results on selecting, improving, protecting, maintaining, and cultivating plants for urban and rural home, landscape, and special purpose plantings such as parks, roadsides and shopping centers.

Florist and nursery crops fulfill a social as well as an agricultural need. They affect human feelings and attitudes and greatly enhance human surroundings. Green plants and flowering plants are being used increasingly in and around homes, offices, and public buildings. The retail value of foliage and pot plants is estimated at over \$1 billion annually. The growth in the bedding plant industry in the last few years is probably unexcelled by any other agricultural commodity.

The USDA research program in Florist and Nursery Crop Production Practices is located at three primary centers: Washington, D.C.--Beltsville, Maryland; Delaware, Ohio; and Corvallis, Oregon. Significant research activities are also located at Tifton, Georgia; Mandan, North Dakota; and Puyallup, Washington. These programs are located at Federal and State research stations where USDA-ARS scientists work closely with State scientists and closely complement research activities in State programs.

Technological Objective 1: New and improved genetic populations, breeding lines, and cultivars of florist and nursery crops that combine improved and favored quality characters with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling.

NPS Contact: A. E. Thompson

Research Locations:

Washington, D. C.
Beltsville, Maryland
Mandan, North Dakota
Delaware, Ohio

Examples of Recent Progress:

Mildew resistance in lilacs - National Arboretum, Washington, D.C. Basic germplasm has been selected for development of lilac (Syringa) cultivars resistant to mildew (Microsphaera alni). Germplasm analysis of Syringa cultivars and species revealed only moderate tolerance to susceptibility among cultivars and resistance in certain species. A hundred mildew-resistant plants were recovered from S. oblata seedling populations raised from diverse Korean seed

collections. The mildew-resistant S. oblata plants, which tolerate heat, are compatible with S. vulgaris and hybrids. They have flowers similar to S. vulgaris and provide the first genetic basis for disease-free lilac cultivar development.

Improved cold hardiness in camellias - National Arboretum, Washington, D.C. Field trials of F₁ and backcross hybrids involving Camellia oleifera have shown that this species transmits a high degree of winter cold hardiness to its progeny. This characteristic, along with its relative compatibility with other species of the section Paracamellia (C. sasanqua, C. hiemalis, etc.), makes it a valuable source for the development of fall-flowering camellias with greater cold hardiness. Fertile C. vernalis cultivars recently introduced from Japan have proven to be compatible with species of both sections Paracamellia and Camellia. C. vernalis can thus serve as a "genetic bridge" for the transfer of germplasm from C. oleifera etc., into C. japonica, C. reticulata, etc. to create more cold hardy spring-flowering camellias.

Possibility for new flower colors in camellias - National Arboretum, Washington, D.C. A germplasm source of yellow flower pigment in camellias has been sought by growers and breeders for several decades. Five seeds of the yellow flowered species, Camellia chrysantha, were obtained in 1980 from the Yunnan Botanical Garden in the Peoples Republic of China. Four vigorously growing seedlings were obtained. The new species has been successfully grafted on C. sasanqua and C. japonica rootstocks and will be forced into rapid growth with the hope that these grafted plants will flower within 2 years. Vigorous attempts will be made to hybridize C. chrysantha with existing cultivars to provide the opportunity of incorporating a wide spectrum of new flower colors into camellias.

New types of iris being developed - National Arboretum, Washington, D.C. Intra- and interspecific hybridization of Iris kaempferi is resulting in the development of new floral forms and colors, extending the blossoming season, the longevity of individual flowers, and development of short-stem forms. A series of elite flower types, including several with blooms lasting up to 5 days, is under propagation for stock release.

Tissue culture propagation system for Yucca developed - National Arboretum, Washington, D.C. Experiments have indicated that Yucca glauca flower pedicels are an excellent explant source for tissue culture experiments. Propagation of yucca, by seed or offshoots, however, is an extremely slow process. Tissue culture represents the only possibility for large scale, rapid clonal multiplication of elite forms. An extensive tissue culture propagation experiment was carried out with a wide range of growth regulator combinations. Shoot development was obtained with several treatments. These treatments will provide the basis for further experiments aimed at making mass propagation of yucca cultivars feasible.

Tissue culture propagation of lilacs - Beltsville, Maryland. Callus induction from vegetative parts of mature wood or from anther culture of lilac has proved to be relatively easy to obtain. After three seasons of culture, it can be stated that regeneration of shoots and roots from callus of flowering age wood is very difficult. By comparison, culture of juvenile stage wood has recently resulted in numerous shoots. One complete plant of the variety 'Easter Staley' has developed.

Flavonoid compounds as chemotaxonomic markers to strengthen plant patent laws - Beltsville, Maryland. Fourteen of 17 flavonoid compounds have been identified from the rose. These compounds can be used to distinguish or "fingerprint" rose cultivars. They provide an objective method for determining taxonomic relationships among cultivars and distinguishing between cultivars that cannot be separated visually on the basis of flower color or other morphological characteristics.

Incompatible, interspecific crosses of Impatiens rescued by ovule culture - Beltsville, Maryland. Embryos of incompatible interspecific crosses of Impatiens could not be cultured by conventional methods because of early abortion. Seedlings from seven wide crosses were obtained by ovule culture. Ovule culture offers the opportunity to incorporate new flower colors and other horticultural characteristics in crosses that cannot be made by conventional breeding.

Tissue culture propagation of woody species - Mandan, North Dakota. Tissue culture techniques enhance vegetative propagating of desirable genotypes. Studies to determine optimum growth media and techniques were initiated for elms, poplars, hackberry, Chinese honeylocust, bur oak, Scotch pine, ponderosa pine, and lodgepole pine. Complete plantlets, with functional roots, have been obtained with Populus nigra. Callus formation and shoot initiation have been achieved with Celtis occidentalis and Gleditsia sinensis. Callus formation has been induced in Quercus macrocarpa, Pinus contorta, and Pinus sylvestris. Tissue culture techniques will reduce time and labor requirements for propagation of genetic material for the breeding program, and will provide a source of disease-free material for disease resistance screening.

Siberian elm disease resistance - Mandan, North Dakota. A selective survey of Siberian elm cankers was undertaken in eastern Montana, eastern South Dakota, western Minnesota, and North Dakota. The study confirmed the presence of Botryodiplodia hypodermia and Tubercularia ulmea in windbreak trees over a larger area than previously reported, and indicates a high probability of finding Siberian elm cankers wherever Siberian elm windbreaks are located in the Northern Great Plains. Therefore, a genetic improvement program for Siberian elm should include the testing of germplasm for resistance to B. hypodermia and T. ulmea. B. hypodermia appears to be the most important of the two pathogens, and selection for resistance to it has been undertaken.

Technological Objective 2: New and improved cultural and management practices that increase florist and nursery crop yields, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.

Research Locations:

Tifton, Georgia
Beltsville, Maryland
Delaware, Ohio

Corvallis, Oregon
Puyallup, Washington

Examples of Recent Progress:

Plant size and quality determined by nutrient balance - Tifton, Georgia. Color, weight, and shape of woody nursery plants can be governed by the specific relationship of the concentration of such trace elements as zinc, iron, and manganese. This finding offers the commercial producer and homeowner the opportunity of producing quality plants with reduced costs for pruning and shaping of the nursery plants.

Technological advancements in plant tissue drying and laboratory analysis - Tifton, Georgia. Microwave drying of laboratory plant tissue samples can result in significant energy, labor, and time savings. None of the 11 elements tested was affected by this new type of tissue drying. Plant leaves were dried in 12-15 minutes by microwave radiation in contrast to 12-18 hours by conventional oven. This technique is also adaptable for moisture determinations of wheat, peanuts, and other crops, and should result in more rapid distribution of research data and tests performed on consumer plant tissue samples.

Variations in symptoms of hydrangea virescence - Beltsville, Maryland. Lethal decline induced by the severe type of hydrangea virescence is prevented when hydrangeas are first infected with the mild type of the disease and subsequently challenged with the severe disease agent. In nature, variation in virescence symptoms may result from mixtures of different strains of the mycoplasma.

Factors affecting rooting of cuttings - Corvallis, Oregon. In leafy pea cuttings, about 50% of the adventitious root formation was due to carbohydrates supplied by photosynthesis during the rooting period. Saturating amounts of an externally supplied growth regulator, indole-butyric acid (IBA), stimulated rooting by an additional 50%. The effects of exogenous IBA and photosynthesis were nearly additive.

Biotypes of rose powdery mildew - Corvallis, Oregon. The occurrence of biotypes of Sphaerotheca pannosa var. rosae has frequently been suggested but has not been well documented. New rose cultivars are often released as "immune" or "resistant" to powdery mildew, but frequently exhibit variable susceptibility when grown in different geographic locations. The existence of biotypes of rose powdery mildew has now been verified, and it has been concluded that biotypes can be characterized by differential rose cultivars. Knowledge of these reactions is important for the breeding and selection of new roses.

Biocontrol of rose powdery mildew by hyperparasites - Corvallis, Oregon. Tilletiopsis sp., a mycoparasite of cucumber powdery mildew, was shown to attack rose powdery mildew (Sphaerotheca pannosa var. rosae) grown on rose leaf discs. Interactions between S. pannosa var. rosae and Cephalosporium sp., Cladosporium sp. and Penicillium sp. have also been observed. Only Tilletiopsis sp. and Cephalosporium sp. appear to attack S. pannosa var. rosae at an early stage of development and could therefore be considered as potential biocontrol agents. None of the mycoparasites tested offers sole potential for biocontrol in commercial greenhouses, but may be useful in reducing the need for frequent applications of chemicals.

Technological Objective 3: To enhance environmental quality by reducing pollution and improving human surroundings.

Research Locations:

Beltsville, Maryland
Delaware, Ohio

Examples of Recent Progress:

Coleus cultivars differ in sensitivity to environmental stress - Beltsville, Maryland. Significant differences in sensitivity to SO_2 pollution were found between two cultivars of coleus. Under ambient CO_2 and SO_2 levels, Buckley Supreme had twice the transpiration rate as Marty. SO_2 pollution also reduced the content of chlorophyll in both cultivars, but its effect on anthocyanin content differed within the cultivars. The anthocyanin content was increased in Marty but decreased in Buckley Supreme. The difference in response appears to be conditioned by genetic factors. Seedlings of these two cultivars were screened, evaluated, and selected for tolerance to such environmental stresses as sulfur dioxide (SO_2), ozone (O_3), and drought. Marty showed resistance to all three stresses, whereas Buckley Supreme was quite susceptible to all three.

Variation in tolerance of shade trees to SO_2 pollution - Delaware, Ohio. Field data from plants growing at high- and low-ambient pollution sites suggest that at least part of the mechanism responsible for tolerance to sulfur dioxide pollution may reside in the plant's ability to metabolize and translocate absorbed sulfur compounds out of affected leaves before damage can occur. These findings indicate the possibility of applying exogenous chemicals to enhance this metabolic/transport phenomenon and thereby increase the potential SO_2 tolerance of selected landscape trees.

CULTIVARS RELEASED

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>Chrysothemis pulchella</u> 'Amazon'	ARS	New type container-grown ornamental
<u>Hibiscus syriacus</u> 'Helene'	ARS	Multistemmed, erect, densely branched shrub
<u>Magnolia</u> 'Galaxy'	ARS	Tree form, late flowering, improved red purple color, wide adaptation
'Nimbus'	ARS	Single or multiple stemmed upright tree, smooth gray bark, white fragrant flowers
<u>Torenia fournieri</u> 'Para Pink'	ARS	New bedding and hanging basket-type flowering plant
<u>Viburnum</u> 'Chesapeake'	ARS	Compact shrub with abundant flowering, dark green foli- age, and good autumn coloration
'Eskimo'	ARS	Dwarf shrub with dense dark green foliage and abundant flowering

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National Research Program 20040

BREEDING AND PRODUCTION - CORN, SORGHUM, AND MILLETS

Technological Objective 1: New and improved genetic populations, breeding lines, and hybrids of corn, sorghum, and millets that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling. Develop basic genetic, cytogenetic, physiologic, and biochemical knowledge necessary to accomplish these goals.

This program is part of the USDA-ARS Mission 2 - Agricultural Production Efficiency with the goal of producing new knowledge and improved germplasm to increase grain productivity. These important feed grains (see NRP 20100 for forage aspects of these commodities) are of major significance for both domestic and export utilization as food, feed, and industrial use. To a lesser degree the program contributes to Mission 3 - Agricultural Marketing and Distribution and Mission 10 - Foreign Agricultural Development. The program is organized under two technological objectives.

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Research Locations:

Gainesville, Florida
Tifton, Georgia
Urbana, Illinois
Manhattan, Kansas
West Lafayette, Indiana
Ames, Iowa
Mississippi State, Mississippi
Columbia, Missouri
Lincoln, Nebraska
Raleigh, North Carolina
Wooster, Ohio
Brookings, South Dakota
College Station, Texas
Mayaguez, Puerto Rico
Kenya, East Africa

Examples of Recent Progress:

Corn:

Plasmid-like DNA's isolated from male-sterile sorghum - Gainesville, Florida.
Examination of 23 male-sterile sorghum cytoplasms revealed that one of the nine

groups differentiated by restriction endonuclease analyses yielded two linear DNA molecules within the mitochondrion. These molecules, which appear to play a prime role in male sterility in the S male-sterile cytoplasm of maize, are similar to the maize DNA's in molecular weight, but are structurally different. These observations suggest that small DNA's may be intimately involved in cytoplasmic male sterility in at least two species.

Recurrent selection for resistance to corn earworm based on indexes as criteria for selection - Tifton, Georgia. Testing three selection indexes against each other and against direct selection is complete for three cycles of selection. The index placing most importance on husk tightness gave best results among the indexes, and also exceeded direct selection for corn earworm resistance in terms of progress/cycle. The ineffective indexes will be discontinued, but the best performing one will be used on a continuing basis to improve resistance to the corn earworm.

Surveying corn in the Southeast for aflatoxin contamination - Tifton, Georgia. Surveys of preharvest corn, over the last several years, suggest that incidence and levels of contamination may be higher from year to year than originally believed. Evidence is now clear that many insects such as corn earworm, fall armyworm, European corn borer, and maize weevil all can enhance fungal infection and aflatoxin contamination when environmental conditions are favorable. This contamination is less evident on resistant and adapted corn hybrids.

Response to reciprocal full-sib and mass selection in corn - Ames, Iowa. Ten cycles of mass selection in two synthetic varieties (BS10 and BS11) were effective for increasing number of ears per plant, but no correlated response for grain yield improvement was realized. Reciprocal full-sib selection was effective for increasing grain yield of BS10, BS11, and their cross and also for increasing number of ears per plant. This form of selection was also more effective for improvement of other agronomic traits.

Selection indexes for improvement of opaque-2 corn - Ames, Iowa. Data from genetic studies in an opaque-2 synthetic were used to calculate selection indexes for use in recurrent selection. Through use of restricted indexes, satisfactory gains were made in kernel hardness, moisture, protein, and protein quality. Use of selection indexes appears promising for combining grain quality with satisfactory yield and other agronomic traits.

Severe loss attributed to combination of maize dwarf mosaic and maize chlorotic dwarf infection in corn plants - Mississippi State, Mississippi. Corn plants showing mosaic symptoms (maize dwarf mosaic) as well as vein clearing, leaf discoloration, and stunting (maize chlorotic dwarf) before silking were delayed in silking by 11 days and produced only 5% as much grain as corn plants that were not diseased.

Survey of U.S. corn germplasm base - Columbia, Missouri. A survey based upon 53 responding corn seed producers accounted for 1.3 billion pounds of seed. Inbred lines B73, Mo17, A632 were each involved in more than 100,000,000 pounds of hybrid seed production. Sources of new lines were primarily reselected in the F₂ generation of existing superior single-cross hybrids. An increase in use

of C-male-sterile cytoplasm was reported. It is used to produce about 14% of the corn hybrid seed sold.

Search for genetic tolerance to ASPERGILLUS FLAVUS and low levels of aflatoxin in maize - Columbia, Missouri. Annual teosinte, collected in Mexico, was challenged by *A. flavus*. Three lots were relatively low in aflatoxin production (<67, <70, and <75 ppb). Companion corn kernels contained from 717 to 80,000 ppb. Of 32 Guatemalan and 50 exotic open-pollinated flint corns, 8 of the Guatemalan and 12 of the exotic collections showed very preliminary indications of possible low aflatoxin production.

Genetic identification of corn lines and crosses by using isozymes - Raleigh, North Carolina. An analysis of the "fingerprints" for 23 isozyme loci in 342 publicly available inbred lines showed 293 (86%) distinct patterns. These results indicate that isozyme techniques provide precise information for characterizing genetic strains, discrimination among inbred lines, and among varieties. This technique can serve the corn industry as an aid to quality control, as a replacement for expensive grow-outs of seed lots, and as a means for providing precise information in cases involving plant protection rights.

Chromosomal locations of enzyme loci determined - Raleigh, North Carolina. Linkage relationship and chromosomal locations of 15 genetic loci associated with corn enzymes were determined. These chromosome markers will contribute to a more complete chromosome map in corn. Such information is very useful for evolution studies and in biochemical and developmental genetics.

Tolerance to ASPERGILLUS FLAVUS may be under genetic control - Raleigh, North Carolina. Two inbred lines with a common genetic background had the lowest levels of aflatoxin, an indication that tolerance may be genetic--at least in part--and that breeding for resistance may be possible. In an interregional study, eight open-pollinated varieties and four current hybrids were little different for naturally occurring aflatoxin contamination in the field, an indication that the problem is not necessarily due to growing current hybrids.

Wild relative of corn is resistant to the most severe virus disease of corn - Wooster, Ohio. A few backcross plants from (corn X *Zea diploperennis*) X corn were resistant to maize chlorotic dwarf virus (MCDV). This wild relative is resistant to MCDV, the most severe, widely distributed virus disease of corn. Yield losses have been as high as 70%. Resistance has not been found in corn, although differing levels of tolerance do exist. The above described transfer to corn germplasm gives promise to eventual development of resistance to this devastating virus which occurs in the Southern Corn Belt and throughout the southern corn-growing states.

New technique developed for inoculating corn plants with maize dwarf mosaic virus - Wooster, Ohio. Transmission of maize dwarf mosaic virus by use of solid stream inocula was developed and demonstrated to be more efficient than the standard finger rubbing or artist airbrush methods of inoculation. In large-scale greenhouse inoculation tests, the new method was at least 20-30 times more rapid than either former procedure, and was as consistent. The new capability will permit screening of much larger populations for virus resistance, and may be used to produce virus-infected tissues on a large scale.

Progress made toward establishing a method of measuring reaction to corn rootworm - Brookings, South Dakota. A number of corn inbred lines were evaluated in four environments at pretassel and kernel milk stages for root characteristics (vertical pull resistance, dry weight, spread). An objective of the experiment was to determine the potential of each root character as an indicator of tolerance to rootworm damage. Highly significant differences were obtained for all characters among inbreds. It was concluded that these root characteristics are relatively stable over environments so effective selection should be possible.

Sorghum:

Preliminary tests indicate mildly stressed sorghum plants outyield nonstressed plants - Lincoln, Nebraska. In a test of interactions of high temperatures and drought stress on plants grown in hydroponic culture, mildly stressed plants yielded more than nonstressed or severely stressed plants at both high and low temperatures. An apparent stress conditioning response occurred at near -4 bars water potential. Photosynthetic rates of 3-week-old plants were also more stable and generally higher when stressed at -4 bars than nonstressed plants. Lines from a population previously selected for high desiccation tolerance also had more stable photosynthetic rates when drought stressed at -4 bars than those identified as having low desiccation tolerance.

Third race of downy mildew on sorghum - College Station, Texas. Most commercial sorghum hybrids, previously considered resistant, are susceptible to this new race. Of 60 hybrids considered resistant in previous tests involving the first two races, only two proved to be resistant to all 3 races.

Search for apomixis in sorghum - College Station, Texas. Attempts are underway to develop lines of sorghum with obligate apomixis (asexual seed production) that can be used to establish apomictic hybrids that are true-breeding. In this way hybrids could be produced rapidly and on a large scale without the need for crossing fields for hybrid seed production. Wild sorghums were collected in Australia, Africa, and Texas as possible sources of apomixis.

Winter nursery program in Puerto Rico - Mayaguez, Puerto Rico. A total of 123 F₂ populations from the sorghum conversion program were sent to Texas where early maturing, dwarf segregates will be identified. Over 2,800 sorghum lines and 5 bulk populations were grown for Texas, 1,500 for Arizona, 3 populations and 938 lines for Georgia, 234 lines for Nebraska, and 532 lines for Oklahoma. Corn breeding lines numbering 400 were grown for Iowa, 183 for Ohio, and 2,300 for Missouri. A total of 316 additional items including corn, Pearl millet, and Teosinte were grown for Georgia. The winter nurseries in Puerto Rico are a very important part of the overall cereal improvement program.

Sweet-stalk corn development project established - Tifton, Georgia. Work is well underway toward identification of high stalk-sugar corn genotypes among commercial hybrids, sub- and open-pollinated varieties, and inbred lines. Appropriate crosses are being made to study inheritance patterns and to establish populations for recurrent selection of high stalk-sugar types.

INBRED LINES RELEASED

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>SORGHUM</u>		
N30	SEA-Nebraska AES	Early Maturity
N31	SEA-Nebraska AES	No bloom (wax) on stems and leaves--associated with greenbug nonpreference feeding
N32	SEA-Nebraska AES	Dominant for Dw, and recessive at other 3 height loci
N34	SEA-Nebraska AES	2 gene dwarf ♀
N35, N36, N38, N39, N40	SEA-Nebraska AES	Combine height ♀ forage sorghum parents
N48	SEA-Nebraska AES	2-gene dwarf height
A2TAM428	SEA-Texas AES	A line with new A2 cytoplasm
B2TAM428	SEA-Texas AES	B line to maintain above A line
A2TX624	SEA-Texas AES	A line with new A2 cytoplasm
B2TX624	SEA-Texas AES	B line to maintain above A line
A2TX2788	SEA-Texas AES	A line with new A2 cytoplasm
B2TX2788	SEA-Texas AES	B line to maintain above A line

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>PEARL MILLET</u>		
Tift 23DAE	SEA-Georgia AES	Early maturity, photo-period insensitive, resistant to lodging, is cytoplasmic male sterile
Tift 23DBE	SEA-Georgia AES	Early maturity, photo-period insensitive, resistant to lodging, is self fertile
Tift 756	SEA-Georgia AES	Early maturity, photo-period insensitive, resistant to lodging, is self fertile; sterility maintainer for A ₁ sterile cytoplasm ¹ in Tift 23DAE

NONCOMMERCIAL GERMPLASM RELEASED

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
H102	SEA-Indiana AES	Resistant to <u>Helminthosporium turcicum</u> races 1 and 2; <u>Collectotrichum graminicola</u> leaf blight; <u>Peronosclerospora sorghi</u> and has some tolerance to <u>H. maydis</u>
H103	SEA-Indiana AES	Resistant to <u>H. turcicum</u> and <u>C. graminicola</u> leaf blight and stalk rot

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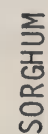
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National Research Program 20050

BREEDING AND PRODUCTION--SMALL GRAINS (WHEAT, OATS, BARLEY, RICE, RYE, TRITICALE, WILD RICE, BUCKWHEAT)

Technological Objective 1: New and improved genetic populations, breeding lines, and varieties of small grains that combine greater yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, responsiveness to new cultural and management practices, and adaptation for mechanized culture, harvesting, and handling.

This National Research Program involves research in breeding and production of the cereal small grains to develop new and improved genetic and cultural methods that will result in lower costs and better quality to consumers and increased efficiency of production for growers. Research agronomists, geneticists, plant pathologists, plant physiologists, cereal chemists, and other scientists work in a team approach to evaluate and improve small grain varieties and improve cultural methods, or conduct basic research to provide the scientific information necessary to improve techniques of breeding or evaluation.

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Research Locations:

Palmer, Alaska
Tucson, Arizona
Stuttgart, Arkansas
Davis, California
Gainesville, Florida
Aberdeen, Idaho
Urbana, Illinois
Ames, Iowa
Manhattan, Kansas
Crowley, Louisiana
Beltsville, Maryland
East Lansing, Michigan
St. Paul, Minnesota
Columbia, Missouri

Bozeman, Montana
Lincoln, Nebraska
Fargo, North Dakota
Wooster, Ohio
Stillwater, Oklahoma
Corvallis, Oregon
University Park, Pennsylvania
Mayaguez, Puerto Rico
Brookings, South Dakota
Beaumont, Texas
Logan, Utah
Pullman, Washington
Madison, Wisconsin

Examples of Recent Progress:

Small Grains in General:

Seed increase - Aberdeen, Idaho. Over 4,600 single or multi-row plots and over 1,500 spaced plants of oats, barley, and wheat were grown for 17 SEA/AR,

Agricultural Experiment Station, and industry projects located in 10 States in 1980. No accessions from the Small Grains World Collection were increased at Aberdeen in 1980.

Seed Increase - Obregon, Mexico. About 30,000 selections, genetic lines, and separate seed lots of durum, hard red spring wheat, and barley were grown in the winter increase program conducted cooperatively by SEA/AR, the Crop Quality Council (Minneapolis, Minnesota), and the North Dakota, South Dakota, and Minnesota Agricultural Experiment Stations. This service is provided to small grains research personnel in the spring grain area. Use of the winter nursery allows advance of an extra generation per year toward homozygosity, additional selection for favorable characters and disease resistance, identification of certain genetic traits such as daylength sensitivity, plus seed increase for yield and quality tests.

Special nurseries - Beltsville, Maryland. Three international and four uniform wheat and oat nurseries, consisting of 1,018 entries, were prepared and distributed to 140 locations in 41 countries for determining reactions to different biotypes of disease-producing organisms. In addition, two more wheat international nurseries were distributed from Lincoln, Nebraska, and approximately 20 uniform nurseries involving wheat, oats, barley, and rice were distributed within the United States from project locations other than Beltsville. Most of the latter are performance nurseries where advanced breeding lines are tested for characters such as yield, disease resistance, and lodging resistance.

Wheat:

Loss in winter wheat caused by Barley Yellow Dwarf Virus (BYDV) similar to that in oats and barley - Urbana, Illinois. Recent studies indicate that fall infection with BYDV in winter wheat reduces grain yield an average of 61 percent; spring infection reduces yield an average of 38 percent. No winter wheats yet tested have outstanding tolerance to BYDV: but some Agrotricum selections from Oklahoma have excellent tolerance.

Quality testing of Hard Red Winter Wheat breeding lines - Manhattan, Kansas. About 1,316 early generation samples of hard winter wheats were evaluated on a small scale for milling and baking quality. Nearly half (41%) had promising functional properties. A total of 286 larger size samples of advanced breeding lines and recently released varieties were more thoroughly tested. About one-third of that number had good milling and baking quality. Among these will be leading commercial varieties of tomorrow. Several in both series have higher grain protein than check varieties, an item of considerable importance for future varieties of hard winter wheat.

Most of 88 wheat varieties readily identifiable by electrophoretic patterns - Manhattan, Kansas. Polyacrylamide gel electrophoretic (PAGE) pattern of the gliadin component of wheat provides for variety differentiation, except in the case of very closely related varieties. The 88 varieties classified by gliadin patterns comprised 89.3% of the total wheat acreage in the United States in 1979.

Amino acid sequences of basic proteins known as purothionins, in the genus TRITICUM, have been completely preserved during evolution - Manhattan, Kansas. Hexaploid wheat, *T. aestivum*, with genomes A, B, and D, is characterized by three forms of purothionin (α_1 , α_2 , and β) that are similar in amino acid sequence. Tetraploid wheat, *T. durum*, with genomes A and B, produces two forms (α_1 and β). *T. monococcum*, a diploid, with only the A genome, produces only β -purothionin.

International Winter Wheat Performance Nursery (IWWPN) provides important research information - Lincoln, Nebraska. The 12th IWWPN grown in 1980 contained 30 entries (from 17 countries) evaluated at 68 locations in 38 countries. Twenty varieties in 1979 exceeded the check variety Bezostaya 1 in yield, indicating substantial international progress in improving productivity of winter wheat. A total of 85 high-protein, high-lysine experimental winter lines and 95 spring lines were distributed to 48 international sites for evaluation in 1980.

Quality testing of Hard Red Spring Wheat and Durum breeding lines - Fargo, North Dakota. Quality evaluation tests were conducted on 1,320 Hard Red Spring and 843 durum samples. An additional 14 large-scale Crop Quality Council Hard Red Spring lots were processed for evaluation by this laboratory and by industry-participating collaborators. Volcanic ash added to Hard Red Spring Wheat decreased test weight. Ash values of the flour increased slightly, but added ash had little effect on flour or bread color. Texture of bread baked from the flour was more open and irregular than the control.

Fiber breads provided for human feeding trials - Fargo, North Dakota. Over 2,000 loaves of frozen bread dough were furnished to the SEA Human Nutrition Laboratory at Grand Forks, North Dakota. Both white flour and white flour with different fiber sources added were used. Cooperative work was started with the Veterans Administration Hospital in Fargo and with the North Dakota State University Pharmacy Department on the binding effect of fiber on medicines.

Quality testing of Eastern Soft Red Wheat and Soft White Winter Wheat - Wooster, Ohio. A total of 243 drill plot (large size) and Regional nursery composite samples, plus 1,431 advanced experimental lines and 2,780 early generation genotypes were tested for milling and baking quality. The breeding material originated from 16 State (or Canadian Province) Experiment Stations.

New method of measuring inherent flour yield of soft wheat genotypes - Wooster, Ohio. Wheats differing in "millability" can be detected through a test for sizing flour content. This is a measure of the amount of potential flour still attached to bran at a specific early stage in the milling process. There is considerable range among soft wheat genotypes in this character, and it is largely a varietal character--therefore, improvement through emphasis in breeding should be possible. Hopefully, we can increase flour yield in soft wheat through this selection procedure.

Attempt being made to transfer resistance to Hessian fly, greenbug, and wheat streak mosaic virus from rye to wheat - Stillwater, Oklahoma. After successful transfer of resistance to race C of greenbug from rye to wheat, attempts to transfer resistance to Hessian fly, wheat streak mosaic virus, and possibly additional Greenbug resistance, from rye to wheat, are underway. Rye possesses

extremely useful resistance to several wheat pests--useful if successful gene transfers can be made.

New gene for resistance to both common and dwarf bunt - Corvallis, Oregon. A newly discovered gene provides effective protection from all known races of common and dwarf bunt. Of particular importance now is the fact it can be used as a new and very valuable source of resistance to dwarf bunt (TCK).

Quality testing of Western wheats - Pullman, Washington. Milling and baking evaluations were determined on 2,058 samples from breeding lines. An additional 4,255 early generation samples (F_3 - F_4) were evaluated for milling and baking quality by small scale tests. Of these, 39% had some desirable quality features. An additional 1,000 single early generation plants were screened for milling quality and grain protein by micro tests. Protein and lysine were determined on 1,100 Hard Red Winter lines derived from crosses designed to increase protein and lysine. Quality testing is an integral part of SEA/AR wheat improvement programs.

High-temperature, adult plant resistance to wheat stripe rust remains nonspecific - Pullman, Washington. This type of resistance continues to be an effective, durable resistance against all races of the stripe rust fungus in the United States and western Europe. Other types of resistance were ineffective against new races of the pathogen.

Oats:

Crown rust on oats affects straw yield as well as grain yield - Ames, Iowa. Effects of crown rust infection on straw yield ranged from negligible loss for some genotypes to nearly 50 percent loss for others. There were also large differences among lines for effect on harvest index (ratio of grain yield to grain-plus-straw yield). Crown rust is one of the most devastating diseases on oats in the United States.

High frequency of chromosomal abnormalities discovered in plants regenerated from tissue culture of oats - St. Paul, Minnesota. Further assessment of the frequency, origin, and causes of such genetic and chromosomal variability is necessary before an evaluation is made of the use of cell and tissue culture for genetic engineering. These cytogenetic variants from oat tissue cultures can be used to develop cytogenetic stocks for basic genetic studies and to introduce useful genes from related species.

Development of effective freeze test technology - University Park, Pennsylvania. Two cycles of recurrent selection for regrowth from oat crowns which had undergone freeze stress totally eliminated plants of the three least hardy varieties in a four-variety blend. This selection procedure represents a very significant advancement toward an effective means of screening for winterhardiness.

Semidwarf spring oats - University Park, Pennsylvania. In 1980 field tests, several semidwarf oat experimental lines had superior lodging resistance, early maturity, and good grain quality. On an average, the semidwarf lines were 25 percent shorter than the check variety but were equal to the check in yield.

Quality testing of oats - Madison, Wisconsin. A total of 29,951 oat groat samples from 10 states were analyzed for protein and moisture through use of an infrared reflectance analyzer. In addition, 889 straw samples were analyzed by Kjeldahl digestion. Straw samples have been successfully analyzed for protein with the infrared reflectance analyzer.

Characterization of protein bodies from mature oat caryopsis aleurone and starch endosperm - Madison, Wisconsin. Protein bodies from the aleurone and endosperm tissues of mature Froker oats were isolated, examined ultrastructurally, and analyzed for chemical constituents, protein structure, and enzyme activity. The two types of protein bodies differed in total nitrogen, total phosphorus, phytic acid concentration, and in protein composition as revealed by electrophoresis.

Oat varietal identification by electrophoresis and electrofocusing - Madison, Wisconsin. Globulin banding patterns by electrofocusing differed among 17 of 19 varieties tested. Globulin electrophoresis did not distinguish varieties.

Barley:

Barley yields increased under low input agriculture - Tucson, Arizona. Through use of the male sterile facilitated recurrent selection breeding method, an early maturing barley population has been developed which can follow cotton to produce a second crop per year. These barley lines were selected under drought stress by receiving only one irrigation, and that was before planting. When the selected barley lines were grown under such low input conditions, their yield was 120% that of standard barley varieties grown under the same conditions.

Meristem tissue culture technique developed to characterize cereal genotypes for synthesis of mucigel freezing inhibitors - East Lansing, Michigan. Certain cell wall mucigels protect critical meristems by inhibiting growth of ice crystals in barley plants and contribute to hardiness, especially when plants freeze in a wet environment. Preliminary results indicate that these mucigels can be obtained in a more native state from tissue culture than from plant crowns or seeds. Genotypes can be characterized with respect to synthesis of freezing inhibitors.

Malting and feed quality in barley closely related - Bozeman, Montana. Malting quality and large-animal feeding value were found to be closely related through in vitro digestibility and small sample malt quality evaluations. These findings can facilitate selection for desirable malting and feeding characteristics in all barley breeding programs.

New source of tolerance in barley to Barley Yellow Dwarf Virus (BYDV) - Fargo, North Dakota. Progeny from the cross Hordeum vulgare x Elymus mollis back-crossed to barley included segregates that were equal in tolerance to BYDV to barley varieties with the Yd₂ gene.

Causal organism of kernel blight in barley discovered - Fargo, North Dakota. Pseudomonas syringae was identified as the cause of kernel blight that has been associated particularly with Klages barley in the Western States when grown

under sprinkler irrigation. The blight occurred more frequently on irrigated barley following potatoes than after small grain crops.

Quality testing of malting barley - Madison, Wisconsin. About 2,900 breeding lines were analyzed for malting quality. Samples for analysis were received from 12 State and Federal breeding programs.

Effect of barley on cholesterol biosynthesis when fed to chickens - Madison, Wisconsin. Chicken diets containing barley (or other small grains) as the primary energy and protein source revealed substantial decreases (20 - 50%) in cholesterol biosynthesis compared with a corn diet as a control. Of four small grains tested (barley, wheat, oats, rye), barley was the most effective. Similar patterns of response were obtained in rats. In further tests involving commercial barley, barley pearlings, and high protein barley flour, the latter in diets contained the highest level of the inhibitor of cholesterol biosynthesis.

Rice:

New rice variety reduces harvest costs - Stuttgart, Arkansas. The new medium-grain variety 'Mars' is rapidly replacing 'Nato', which has been the leading medium-grain variety in the southern states for 20 years. Increased resistance to lodging and higher yields of Mars means greatly reduced harvesting costs and energy savings.

Fourth genetic element facilitates hybrid rice production - Davis, California. Recessive tall plant type will be incorporated into pollen fertility restoring parents, so that the taller paternal parent will better disperse pollen onto semidwarf female parents, and the resulting F₁ hybrid plants will be semi-dwarf, unlike the usual case of tall hybrids from semidwarf X tall parents. The other three genetic elements are cytoplasmic male sterility, maintainer lines, and fertility restoring lines.

Quality testing of rice - Beaumont, Texas. Amylose and alkali spreading value were used to predict the quality of over 8,000 rice breeding lines. New introductions into the USDA World Rice Collection, 1,390 in number, were tested for cooking, eating, and processing quality. Several had unique hull color, bran color, kernel shape, and amylose characteristics. Numerous quality tests were run on entries in the Uniform Rice Performance Nursery.

Experimental rice lines resistant to blast - Beaumont, Texas. Progenies from the cross Lebonnet X Vista have been identified as resistant to all races of blast (*Pyricularia oryzae*) known to be present in the United States. Their potential is for use as elite germplasm.

Rye:

Ergot increased by BYDV infection in rye - Urbana, Illinois. BYDV infection increased susceptibility of winter rye to ergot, caused by *Claviceps purpurea*. Fall-infected plants had 14 percent sclerotia by kernel weight and 33 percent by kernel count, spring-infected plants had 0.9 percent sclerotia by kernel count and 1.0 percent by kernel count, compared with BYDV-free plants with 0.3 and 0.4 percent for kernel weight and kernel count, respectively.

Technological Objective 2: New and improved cultural and management practices that increase small grain yields through disease, insect, and weed control; that minimize environmental stress; that improve physical and nutritional quality attributes; that minimize production losses; and that conserve and use scarce or irreplaceable resources more efficiently.

Research Locations:

Palmer, Alaska
Gainesville, Florida
Aberdeen, Idaho
Urbana, Illinois
Manhattan, Kansas
Lincoln, Nebraska
Corvallis, Oregon

University Park, Pennsylvania
Brookings, South Dakota
Beaumont, Texas
Logan, Utah
Pullman, Washington
Madison, Wisconsin

Examples of Recent Progress:

Wheat:

Properties of strains of soilborne wheat mosaic virus determined - Lincoln, Nebraska. Results have shown that both RNA components of this virus are necessary for infection and both carry genetic information. Severity of symptoms depends on length of the short rod (virus particle). The short rod is genetically unstable and frequently gives rise to deletion mutants with lower molecular weight RNA in the short rods. These deletion mutants are more readily transmitted by leaf-rubbing inoculation than wild type strains and soon predominate in laboratory cultures maintained by manual inoculations.

Progress made in identification of dwarf bunt (TCK) spores versus common bunt spores - Corvallis, Oregon. Concentrations of 16 minor and trace elements in common bunt spore samples were determined by neutron activation analyses. Results were compared statistically and indicated that concentrations of K and Cl can be used as primary indicators, and Ca and Br as secondary indicators of differences between common bunt and dwarf bunt spores. Another test procedure that shows promise is based on pyrolysis products from analysis of at least 20 milligram samples of each spore type with a curi-point pyrolyzer connected to a quadrupole mass spectrometer.

Sanitizing dwarf bunt (TCK) infected grain by fumigation with methyl bromide - Logan, Utah. In cooperation with the SEA/AR Stored Product Insects Research and Development Laboratory at Savannah, Georgia, methyl bromide was found to be an effective fumigant for killing spores of dwarf bunt in grain. If this procedure can be utilized economically on large-scale treatment of grain, it could provide a solution to the difficulty encountered in sale of Western white wheat to the Peoples' Republic of China.

Varietal requirements needed for best performance under no-till - Pullman, Washington. Plant breeders will need to select short, stiff straw, early maturing wheats that consistently have high test weights for best production under no-till. In paired-plot tests directly comparing no-till and moldboard plow till, several traits were affected in 1979 and 1980: yield, plant height, heading date, test weight, stand (number of established plants), flour yield, *Cephalosporium* severity, and harvest index. No-till generally increased height and delayed maturity.

Biocontrol of Take-all, a soilborne disease of wheat - Pullman, Washington. Significant biological control of Take-all in field plots was documented for the second consecutive year through use of antibiotic-producing, root-colonizing, fluorescent pseudomonad bacteria applied on the seed. Larger scale testing and even pilot testing is planned. The bacterium is a natural inhabitant of wheat roots and apparently gives effective natural control of Take-all after many years of wheat monoculture.

Soilborne pathogens cause 25% yield reduction of annual cropped winter wheat - Pullman, Washington. Yields were increased an average of 20 bushels per acre by soil fumigation in six fields of annual-cropped winter wheat in the Palouse and the irrigated Columbia Basin. Similar results were obtained with soil fumigation every year since 1974. Annual cropping with minimum- or no-till can be energy-efficient and may reduce erosion, but such management can be costly to growers because of root diseases.

Crop management changes are increasing occurrence of rust and powdery mildew epidemics on wheat - Pullman, Washington. Expansion of intensive irrigated agriculture in areas of former dryland agriculture, and into areas where the latter still exists, has markedly increased frequency of stripe rust, leaf rust, and mildew epidemics in the Pacific Northwest. Farming procedures provide a continuous host (green wheat) for survival and increase of the three pathogens (and others) throughout the year. Irrigation provides a much more favorable environment for diseases.

Barley:

Management practices affect incidence of bacterial blight on barley - Aberdeen, Idaho. Incidence of kernel bacterial blight on 1977-79 crop samples from sprinkler-irrigated fields consistently showed double the amount of infection when potatoes had been the previous crop in rotation with small grains, either wheat or barley.

VARIETIES RELEASED

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>WHEAT</u>			
Sterling	Soft White Spring	SEA-Idaho AES, Colorado AES, Oregon AES	Stiff, short straw, early maturity, improved soft wheat quality.
Neeley	Hard Red Winter	SEA-Idaho AES	For use under irrigation and slight advantage in grain protein content.
Irridur	Durum	SEA-Idaho AES	Moderate resistance to stripe rust races found in Idaho, and to provide choice for growing durum.
Florida 301	Soft Red Winter	SEA-Florida AES	Early maturity, with good yield, high test weight. Resistant to prevalent races of leaf rust and mildew, suitable for late plantings in double cropping.
Crestone	Soft White Spring	SEA-Colorado AES (developed by SEA and Idaho AES)	High yield, resistant to powdery mildew and stripe rust.
Auburn	Soft Red Winter	SEA-Indiana AES	Unique combination of excellent winterhardiness, short height, moderately early maturity, resistant to powdery mildew, leaf rust, and Septoria diseases.

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>WHEAT</u>			
Caldwell	Soft Red Winter	SEA-Indiana AES	Unique combination of earliness, high milling and baking quality, resistance to diseases and to Hessian fly. One of the most resistant varieties to Barley Yellow Dwarf Virus, and has unique resistance to Septoria.
Pondera	Hard Red Spring	SEA-Montana AES	High yield, lodging resistance, and heavy test weight.
Marberg	Hard Red Spring	SEA-Montana AES	High yield and lodging resistance.
<u>BARLEY</u>			
Steve	Six-rowed spring feed barley	SEA-Idaho AES	High yield, resistance to lodging, for use under irrigation.
<u>RICE</u>			
M-301	Medium grain	SEA-California Co-Operative Rice Foundation, Inc. and California AES	Short stature, nonpubescent hulls.

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>RICE</u>			
S-201	Short grain	SEA-California Co-Operative Rice Foundation, Inc., and California AES	Short stature, nonpubes- cent hulls, responsive to high N fertilization, high yield.
<u>OATS</u>			
Larry	Spring oats	SEA-Illinois AES, Kansas AES, and Pennsylvania AES	High test weight, improved kernel type, and resist- ance to Barley Yellow Dwarf Virus.
Ogle	Spring oats	SEA-Illinois AES, Nebraska AES, Ohio AES, Pennsylvania AES, New York AES	High yield, superior re- sistance to Barley Yellow Dwarf Virus.

NONCOMMERCIAL GERmplasm RELEASED

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>WHEAT</u>			
16 winter wheat isolines (<i>Triticum aestivum</i> L. em Thell) in Itana background	Hard Red Winter Germplasm	SEA-Washington AES	Four different culm length genotypes in common genetic background.
Benni	Soft Red Winter Germplasm	SEA-Indiana AES	Four to six seeds per spikelet (multifloret) compared to two to four for commercial soft wheats.
Elmo	Soft Red Winter Germplasm	SEA-Indiana AES	Resistance to Barley Yellow Dwarf Virus.
<u>BARLEY</u>			
Composite Cross XXXVII-A, B, C		SEA-BARC	Excellent resistance to leaf rust, powdery mildew, and scald.
<u>BUCKWHEAT</u>			
Pennline 18		SEA-Pennsylvania AES	Self-fertile inbred line
Pennline 25		SEA-Pennsylvania AES	Self-fertile inbred line

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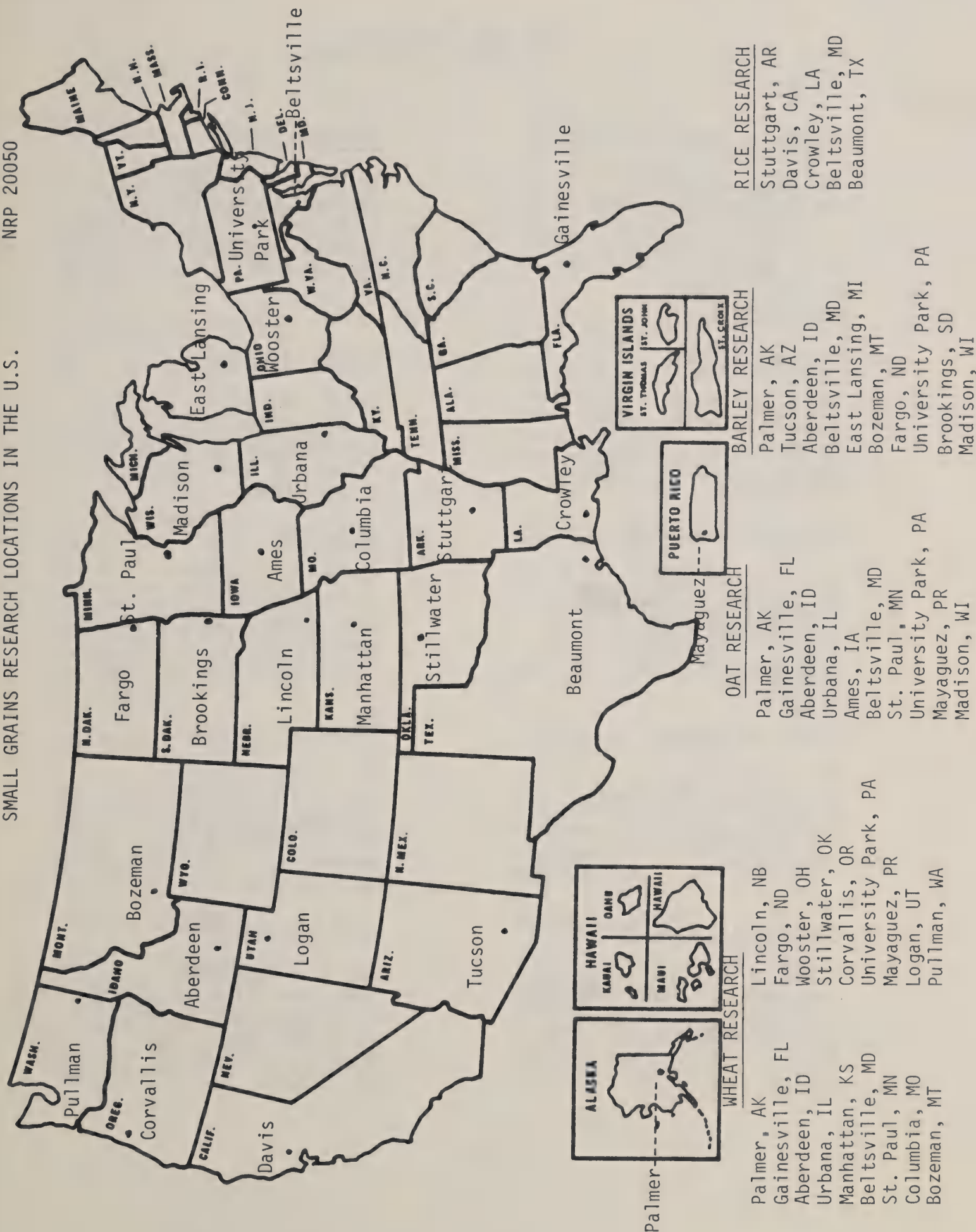
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National Research Program 20060

BREEDING AND PRODUCTION - COTTON

Cotton fiber, and food and feed from cottonseed are vital renewable national resources. Domestically produced cotton fiber reduces our dependence on petroleum-based synthetics. The value of cotton exports exceeded \$1.9 billion for the year ending September 30, 1979. The mission of this national research program is to develop new knowledge which will increase production efficiency and provide consumers with a stable supply of fiber and food at a reasonable cost. The research approaches emphasize genetic improvement and the development of more efficient cultural and management practices.

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Research Locations:

Auburn, Alabama
Phoenix, Arizona
Shafter, California
New Orleans, Louisiana
Mississippi State, Mississippi
Stoneville, Mississippi
Las Cruces, New Mexico
Raleigh, North Carolina
Florence, South Carolina
Knoxville, Tennessee
Brownsville, Texas
College Station, Texas
Lubbock, Texas
Weslaco, Texas

Technological Objective 1: New and improved genetic populations, breeding lines, and cultivars of cotton that combine increased yield potentials and favored quality characteristics of seed and lint with increased resistance to pests, tolerance to environmental stresses, and adaptation to modern cultural, harvesting, and handling practices.

Examples of Recent Progress:

Germplasm identified with resistance to worldwide collection of root-knot nematodes - Auburn, Alabama. (In cooperation with North Carolina State University, Raleigh, North Carolina.) Auburn 623 RNR, a noncommercial germplasm release, continues to show extremely high resistance to root-knot nematode isolates from various cotton-growing regions of the world. This suggests that Auburn 623 RNR is a stable source of resistance. Inheritance studies indicate this resistance is due to multiple genetic factors.

Glandless cottons released which eliminate toxic gossypol from cottonseed - Auburn, Alabama. Eight noncommercial stocks of glandless, gossypol-free cotton were distributed. Glandless cottonseed eliminate the processing costs necessary to detoxify meal for use in nonruminant animal rations. In addition, roasted kernels from glandless cottonseed are used in various bakery products for human consumption.

Two short-statured Pima lines released for use in interspecific hybrid cotton - Phoenix, Arizona. The development of interspecific Upland X American Pima cotton hybrids for commercial production is receiving considerable attention from cotton breeders. Excessive vegetative growth is a persistent problem with these hybrids. The release of Pima 79-103 and Pima 79-106 provides two early maturing, short-statured American Pima lines that have a high degree of height stability over a range of environments. The use of these lines in interspecific hybrids will reduce the problems of excessive vegetative growth of the hybrid.

Nectariless cottons released which reduce populations of Lygus bugs - Shafter, California. Three nectariless noncommercial breeding stocks were released which have fiber properties and Verticillium wilt tolerance essentially equal to the widely grown cultivar Acala SJ-2. These nectariless cottons have shown a 6-17% yield advantage over nectaried cottons under heavy Lygus bug infestations in the San Joaquin Valley. When Lygus bugs are controlled with insecticides, however, yields of these nectariless strains may be slightly less than those of the Acala check.

Improved fiber bundle tester developed - New Orleans, Louisiana. An instrument for measuring the breaking load, elongation, and mass of fiber bundles was constructed and evaluated. Two technicians using these instruments can evaluate as many samples in the same time as three technicians using the current instrumentation. This will accelerate progress in developing germplasm with improved processing and end-use characteristics.

Fiber cohesion measure aids prediction of yarn strength properties - New Orleans, Louisiana. A new commercial cohesion meter was used to measure cohesive force of fibers in sliver form. This measure of cohesive force increases the precision of predicting yarn strength properties from fiber characteristics. From 48 to 58% of the variation in yarn tenacity and yarn energy-to-break can be accounted for by variations in the cohesive force of the fibers in sliver form. Yarn strength properties are a major factor associated with the efficiency of cotton processing.

Photoperiodic race stocks of cotton concerted to flowering types - Mississippi State, Mississippi. Flowering lines of primitive cotton from 68 different accessions collected in Mexico and Central America were released to cotton breeders. These lines, which contain 75% exotic germplasm, will broaden the germplasm base available to public and private cotton breeders. This material is proving to be an excellent source of resistance to diseases, nematodes, and insects.

Technique developed for uniformly infesting research plots with budworms - Mississippi State, Mississippi. A technique was developed for rearing *Heliothis virescens* from pupae to first instar and for applying uniform levels of first instar larvae to cotton plants. Larvae are applied in corn cob grits by using a hand-held inoculator. Only a few workers inoculated 100,000 plants weekly for seven weeks. The resulting infestation of *Heliothis* was sufficient to rate lines for levels of resistance. A publication has been prepared detailing all steps of the operation. This new technology is directly usable by commercial plant breeders.

Nectariless cottons reduce need for chemical pesticide application - Stoneville, Mississippi. A comparison of nectariless cottons with the standard nectaried types in a three-year pilot test indicated that the nectariless trait reduced numbers of *Lygus* bug nymphs by 45% and of adults by 26%. This reduces the amount and number of applications of chemical pesticides needed to control this insect. In 1980, one commercial nectariless variety, based on germplasm developed by SEA/AR and the Mississippi Agricultural and Forestry Experiment Station, accounted for 7% of the U.S. acreage.

Technique developed to measure pollen viability in cotton - Las Cruces, New Mexico. A rapid, simple technique was developed to give the first available means of accurately measuring pollen viability in cotton. A tissue culture approach with a micro-droplet assay method allows the rapid screening of many cultural components in a single experiment. This technique provides a tool to conduct research in many areas, including pollen fertility restoration in hybrid cotton and tolerance of cotton to heat and drought stress.

Germplasm released with resistance to insects - Raleigh, North Carolina. F2-BR-1, a day-neutral flowering selection stemming from exotic germplasm, was released and seed was supplied to public and private breeders. This cotton strain is resistant to spider mites and aphids, and also reduces damage from bollworms. Condensed tannins are thought to be responsible for the resistance.

Experimental breeding line with improved fiber properties released - Florence, South Carolina. The released strain PD 4548 combines exceptional fiber properties with high yield, increased lint percentage, and wide adaptation throughout the Southeastern production region. Fiber properties approach those of the premium Acala cultivars grown in the irrigated West. This PD strain was selected from a broadbased germplasm pool formed by intercrossing domestic and exotic cottons.

Major review of research on boll development published - Knoxville, Tennessee. A detailed review on the development of cotton bolls was completed after extensive examination and reinterpretation of the literature and unpublished data. This is the first comprehensive treatment on boll development. The complete citation is included in the list of publications for this report.

Insect resistance germplasm released - Brownsville, Texas. Two new sources of high bud gossypol were identified in derivatives from hybrids involving feral race stocks and adapted cultivars. This germplasm reduces growth rates and survival of the tobacco budworm larvae attacking cotton.

Early maturing germplasm released - Brownsville, Texas. In cooperation with the SEA/AR program at Weslaco, Texas, and the Texas Agricultural Experiment Station, four stocks were released which combine early maturity, compact fruiting pattern, and improved fiber micronaire. These stocks will be useful in developing cultivars better adapted to short season production systems.

Obsolete varietal collection source of germplasm for improving the composition of cottonseed - College Station, Texas. Selections for increased seed oil from the Upland germplasm collection were crossed with commercial cultivars and F_3 seeds from the segregating populations were evaluated. Unique combinations of oil and physical properties were identified. Seed oil percentage in these populations was inherited in mainly an additive manner, although a large portion of variation in seed oil was also due to environmental effects.

Cottons developed that produce a new antibiotic and have improved pest resistance - College Station, Texas. Breeding lines of cotton which contain the antibiotic raimondal were developed by interspecific hybridization. Two hybrids, *G. hirsutum* X (*G. barbadense* X *G. raimondii*) and *G. hirsutum* X (*G. arboreum* X *G. raimondii*), were used to transfer the raimondal character from the wild diploid species into breeding lines that are both self-fertile and form fertile crosses with cultivated cottons. Most progeny that produce raimondal have also shown increased resistance to Verticillium wilt and are being evaluated for resistance to other diseases and pests.

Exotic germplasm identified as potential source for drought resistance - Lubbock, Texas. Data from both dryland and irrigated plots showed significant variability among exotic entries for shoot growth rate, tap root length, number of root laterals, and general heat tolerance and water-use efficiency. Several of these promising exotic strains have been crossed with commercial cultivars and selections are being made for additional testing.

Technological Objective 2: New and improved cultural and management practices that optimize yield potentials, minimize production losses, preserve quality attributes, and conserve and utilize resources efficiently.

Examples of Recent Progress:

Abscisic acid content of bolls increases with drought - Phoenix, Arizona. The abscisic acid content of cotton bolls increased with stress and was highly correlated with boll abscission rate. This provides correlative evidence that abscisic acid as well as ethylene is a factor in causing the higher rate of boll abscission that occurs when plants are subject to water deficit. A better understanding of the natural growth regulation processes may enable scientists to develop improved management systems for increasing water-use efficiency.

Nitrogen nutrition alters plant-water relations and leaf expansion - Phoenix, Arizona. Nitrogen deficiency causes large reductions in leaf expansion rate. This was shown to result from alterations of plant-water relations leading to decreased turgor in the expanding leaf cells. Nitrogen deficiency causes increased resistance to liquid water flux through the plant and results in a decreased steady-state leaf water potential compared with plants supplied optional amounts of nitrogen. Nitrogen deficiency also decreases cell wall

elasticity which leads to a greater drop in turgor for each unit change in leaf water potential. Because of these changes the normal daytime water deficit experienced by even well-watered nitrogen-deficient plants is enough to inhibit growth. These plants grow mainly at night in contrast to the predominantly daytime growth of the check plants. The diurnal patterns of leaf expansion may provide a rapid and useful screening technique in selecting for nitrogen-use efficiency.

Management of pink bollworm by short season cotton production systems studied in the irrigated West - Shafter, California. Studies at the Brawley Field Station indicate that a short season production system with no insecticide treatments and harvest on September 7, reduced diapausing pink bollworm populations 81% and spring moth emergence by 93%. Yields, however, were reduced significantly. The standard long season production system with eight insecticide treatments and harvest on December 15, produced 445 kilos per hectare more lint than the experimental short season system. Additional research is needed to evaluate alternative systems and comparative net returns.

Double cropping of winter clover and short season cotton appears promising - Shafter, California. Winter clover following short season cotton produced 2,870 kilos per hectare clover hay and appears to eliminate the need for applying nitrogen fertilization to the succeeding cotton crop.

Nematodes reduce cotton yields in the Delta - Stoneville, Mississippi. In a field infested with low to medium populations of nematodes, seedling survival, plant height, and lint yields were increased 5, 3, and 10%, respectively, by preplant soil fumigation with Telone. These increases suggest the importance of developing cost-effective technology to control nematodes in this region.

Experimental plant growth regulators appear promising - Stoneville, Mississippi. Flowering rate, boll set, earliness, and yield were increased by the experimental chemicals DPX-9634, Cytex, and GA₃. Yield increases ranged from 7 to 20% in six DPX treatments, three GA₃ treatments, and one Cytex treatment. Additional testing over a range of climatic and soil growing conditions will be necessary to determine their potential value for cotton production.

Factors influencing metabolism of germinating cottonseed identified - Stoneville, Mississippi. Storage reserves were mobilized more rapidly in germinating high quality cottonseed than in lower quality seed. The principal contrast in seed germination metabolism appeared to be associated with the conversion of lipids to carbohydrates. A better understanding of seed germination metabolism will make it possible to select genotypes or develop growth regulator treatments that will improve stand establishment in cotton.

Biological control of seedling diseases appears promising - College Station, Texas. A fungus with broad potential for control of seedling diseases was isolated from the surface tissue of healthy cotton plants. The fungus, Gliocladium virens, is hyperparasitic and kills most soilborne fungal pathogens that attack cotton and other field crops. Two antibiotics produced by the fungus have been isolated and both contribute to the antagonism of G. virens to pathogenic fungi. Treatment of cottonseed with the live fungus increases the stand and vigor of cotton seedlings growing in soil infested with disease organisms. A mutant of G. virens with increased production of antibiotics was an even better biocontrol agent than the parent isolate against Pythium diseases.

COTTON NONCOMMERCIAL GERMPLASM RELEASE 1980

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
Aub G1-16 Aub G1-56 Aub G1-149 Aub G1-165 Aub G1-201 Aub G1-213 Aub G1-277 Aub G1-310	SEA/AR and Alabama Agricultural Experiment Station, Auburn University, Auburn, AL.	Glandless strains eliminate toxic gossypol from the seed. This, in turn, results in improved quality of the meal for feeding nonruminant animals and a new source of food for human consumption.
Pima 79-103 Pima 79-106	SEA/AR, Phoenix, AZ, and the Arizona Agricultural Experiment Station, University of Arizona, Tucson, AZ.	Early maturing, short- statured strains which may be suitable parents for use in interspecific cotton hybrids.
H 6157 H 7117 H 7140	SEA/AR, Shafter, CA, and California Agri- cultural Experiment Station, University of California, Berkeley, CA.	Nectariless cottons adapted to the irrigated West. Nectariless cottons suppress Lygus bug infestations.
Sixty-eight (68) flowering germplasm lines involving 68 exotic <u>G. hirsutum</u> L. race accessions.	SEA/AR and the Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, Mississippi State, MS.	Broadened germplasm base through conversion of non-flowering exotic race stocks to flowering types which can be grown in the U.S. Cotton Belt.
F2-BR-1	SEA/AR and the North Carolina Agricultural Experiment Station, North Carolina State University, Raleigh, NC.	High tannin strain with resistance to spider mites and aphids.
Pee Dee 4548	SEA/AR, Florence, SC, and the South Carolina Agric- ultural Experiment Station, Clemson University, Clemson, SC.	Combined high lint yield with high fiber strength, high lint percentage, and wide adaptation in the Southeastern Region.
HGT-197-4 HGT-216-8	SEA/AR, Brownsville, TX, and the Texas Agricultural Experiment Station, Texas A&M University, College Station, TX.	High flowerbud gossypol transferred from two wild race stocks. Reduces <u>Heliothis</u> larval growth rate and survival.

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
GH-2-1 GH-8-10 GH-11-9 D-3	SEA/AR, Weslaco and Brownsville, TX and the Texas Agricultural Experiment Station, Texas A&M University, College Station, TX.	Rapid fruiting, early maturing lines adapted to short season pro- duction systems.

P U B L I C A T I O N S

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National Research Program 20080

BREEDING AND PRODUCTION - SOYBEANS, PEANUTS, AND OTHER OILSEED CROPS

NRP 20080 involves research to improve agricultural production efficiency by developing new and improved plant genetic resources and cultural and management practices for soybeans, peanuts, sunflower, flax, safflower, and guar. Plant geneticists, agronomists, plant pathologists, plant physiologists, microbiologists, chemists, entomologists, and soil scientists (both Federal and State) work in a team approach to evaluate and improve oilseeds and to improve cultural methods.

NPS Contact: R. C. Leffel

Technological Objective 1: New and improved genetic populations, breeding lines, and varieties of oilseed crops that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling.

Research Locations:

Davis, California
Gainesville, Florida
Tifton, Georgia
Urbana, Illinois
West Lafayette, Indiana
Ames, Iowa
Beltsville, Maryland
Stoneville, Mississippi
Columbia, Missouri
Raleigh, North Carolina
Fargo, North Dakota
Wooster, Ohio
Stillwater, Oklahoma
Brookings, South Dakota
Bushland, Texas
Suffolk, Virginia

Examples of Recent Progress:

SOYBEANS:

Soybean germplasm tolerant to excessive boron identified - Davis, California. Three soybean lines were identified as tolerant to excessive boron in greenhouse tests of Maturity Groups 00, 0, I, II, III, and IV of the USDA Soybean Germplasm Collection.

Late flowering gene offers optimal vegetative growth under short-day conditions - Gainesville, Florida. The gene from PI 159925, conditioning late flowering under short-day conditions, has been incorporated into improved, pest resistant lines. Backcross lines to Forrest and F 76-8827, when planted July 18, flowered 15 to 20 days later than the recurrent parent, were nearly twice as tall, and matured from November 1 to 30. This material should provide high-yielding, agronomically desirable soybeans for late plantings in subtropical areas of the world.

Effect of Septoria brown spot disease on yield components determined - Urbana, Illinois. Seed weight reductions in the upper, middle, and lower canopy levels of Williams plants were 8, 11, and 16%, respectively, when compared with noninoculated benomyl-sprayed plants. There were no significant differences among treatments in number of pods per plant or number of seeds per pod.

Effect of soybean growth stages on Septoria brown spot disease development determined - Urbana, Illinois. Plants inoculated at flowering (R1) and at the beginning of pod fill (R3) developed less disease than plants inoculated at the second trifoliate (V2) and at the beginning of bean development (R5-R6) stages. The results suggest that soybeans are more susceptible to S. glycines at a very young growth stage and the late stage of pod filling.

Additional source of resistance in soybeans to soybean mosaic virus (SMV) identified - Urbana, Illinois. A Korean soybean line, SS 741186, was resistant to all seven known SMV strains in greenhouse studies. Suweon 97 soybean line was previously identified as resistant to all seven SMV strains.

Seedling inoculation test developed for screening for resistance to brown stem rot - Urbana, Illinois. Two-week-old seedlings were removed from sterile sand, washed, dipped in a mycelial-spore suspension of the brown stem rot fungus, and transplanted to a sterile soil-sand medium. After six weeks of growth, all plants of Williams were infected by the fungus, as compared with 13% of the plants of the resistant line PI 84946-2.

Earlier maturing soybean cyst nematode-resistant germplasm to aid breeders - Urbana, Illinois. A Maturity Group III soybean germplasm line, L77-994, with resistance to races 3 and 4 of cyst nematode, was released to soybean breeders. This is the first improved germplasm with resistance to cyst nematode race 4 for the Midwest.

Enlarged germplasm collection provides basis for nation's soybean breeding improvement efforts - Urbana, Illinois, and Stoneville, Mississippi. Although the germplasm base of U.S. commercial soybean varieties is quite narrow, future soybean variety improvement is assured by the world's soybean germplasm resources maintained in the USDA Soybean Germplasm Collection at Urbana, Illinois, and Stoneville, Mississippi. This collection of more than 9,000 tripled in size in the past 10 years and will provide a diverse genetic reservoir for new and valuable traits such as pest resistance and improved seed quality characters.

Coordination of Uniform Soybean Tests (Northern States) continues to produce superior varieties - West Lafayette, Indiana, and cooperating agencies. A total of 222 soybean strains and varieties were evaluated in 136 tests in 20 states and Canadian provinces. Based on these tests, new varieties Hardin, BSR 302, Sprite, Douglas, and Pixie were released in 1980.

Genes controlling resistance to specific races of *Phytophthora megasperma* var. *sojae* identified - West Lafayette, Indiana (in cooperation with Purdue University plant pathologists). The reactions of races 5, 6, 7, 8, and 9 of the pathogen to soybeans containing the genes Rps_1^a , Rps_1^c , and Rps_3 were determined. A new major gene Rps_4 was identified and the reaction of this gene to nine races of the pathogen was reported. Combinations of two genes that would result in resistance to races 1 through 9 of the pathogen were specified. The results will enable soybean breeders to incorporate into varieties specific genes that will give resistance to the pathogen and identify key races of the pathogen that can be used to screen for the presence of these genes.

Structural genes specifying subunits of storage proteins glycinin identified - West Lafayette, Indiana. The major polypeptides comprising glycinin were purified and studied. Seven with acidic, and five with basic isoelectric points have now been identified unambiguously by using amino acid sequence analysis. Each acidic polypeptide is disulfide-linked to a basic one to form a glycinin subunit. These studies establish that there are a minimum of seven different structural genes specifying glycinin subunits and that a complicated series of post-translational modifications occur during synthesis and deposition of the storage proteins in developing soybeans.

Brown stem rot (BSR) resistant soybean variety released - Ames, Iowa. BSR-302 has 25% greater resistance to brown stem rot infection than the first BSR resistant variety released (BSR-301). Other advantages over BSR-301 include resistance to bacterial pustule and some races of *Phytophthora* rot. It also has a small yield advantage over BSR-301 under both disease and disease-free conditions.

Downy mildew fungus reduces yields of soybeans - Ames, Iowa. The mildew-susceptible variety, Wayne, and the isogenic, resistant line SL-9 were evaluated in the field under an epiphytotic of downy mildew. Seed yields were reduced 19% by the disease.

Additional wild soybean introductions tolerant to budblight - Beltsville, Maryland. Nine additional introductions of the wild soybean *Glycine soja* were identified as tolerant to budblight caused by tobacco ringspot virus.

Demonstration of heterosis in *Glycine max* X *G. soja* hybrids - Beltsville, Maryland. Differences between the hybrids and their parents indicated significant heterosis for plant weight, nodule weight, leghemoglobin content, and N_2 fixation rates, especially when *G. max* Bedford was the female parent.

Soybean genetic base extended - Beltsville, Maryland. Approximately 120 Maturity Group II to V soybean plant introductions (PI's), selected from more than 2,000 lines, were grown in three environments in the mid-Atlantic region to identify germplasm useful for increasing genetic variability. The results clearly indicate that the germplasm originally employed in U.S. soybean breeding programs did not have the highest yield potential available in Asian germplasm. New breeding populations can be developed by using the lines identified in these studies which have the potential to produce varieties with an important yield advantage over currently available varieties.

Analysis of manganese tolerance in soybeans - Beltsville, Maryland. Tolerance of soybeans to excess manganese was determined to behave as a multigenically controlled trait. Cytoplasmic inheritance was also found to be a determining factor in manganese tolerance.

New accessions of nitrogen-fixing bacteria from China - Beltsville, Maryland. Nitrogen-fixing isolates of *Rhizobium* from soybean nodules were obtained from the Peoples Republic of China and added to the USDA *Rhizobium* Culture Collection. Efficient N₂ fixers were identified in the greenhouse and field.

Efficiency ratings for the U.S. soybean bacteria - Beltsville, Maryland, in cooperation with the University of California at Davis. Collection of nitrogen-fixing *Rhizobium japonicum* from soybean varieties from major U.S. production areas was conducted to ascertain the relative nitrogen fixation efficiency of isolates as determined by hydrogen uptake (Hup+). Serological determinations of the isolates were made to correlate efficiency among serological groupings. Fifteen hundred isolates of *R. japonicum* from 76 field locations in 33 states were assayed for hydrogen uptake; of these, approximately 25% were Hup+ and fell within two to three major serological groups. Hydrogen uptake and nitrogen fixation efficiency appear to be closely correlated in some soybean/rhizobia symbiosis.

Identification of *Rhizobium japonicum* strains with genetic exchange ability - Beltsville, Maryland. Screening diverse strains of the nitrogen-fixing symbiont of soybeans for gene transfer has resulted in the identification of six strains as genetic exchangers (GE). GE strains may prove to be the source of genetic materials that will permit the mapping and identification of genes controlling symbiotic nitrogen fixation.

Rhizobium mutants affecting soybean nodulation - Beltsville, Maryland. *Rhizobium* mutants that form apparently normal nodules on soybeans but do not fix nitrogen have been found to lack specific proteins involved in symbiotic nitrogen fixation.

Tryptophan biosynthesis defined in *Rhizobium japonicum* - Beltsville, Maryland. The precise characterization of tryptophan auxotrophs using enzyme activity measurements has defined the specific metabolic block characteristic of 10 mutant strains of *Rhizobium japonicum*. These mutations will be of use as genetic markers for mapping and identifying genes controlling symbiosis.

Coordination of Uniform Soybean Tests (Southern States) continues to produce superior varieties - Stoneville, Mississippi, and cooperating agencies. A total of 222 soybean strains and varieties were evaluated in 162 tests in 18 states. Nathan was released as a productive variety developed specifically for those areas where race 4 of the soybean cyst nematode is a problem and where a variety maturing earlier than Bedford is desired. Nathan is of early Maturity Group V and is also resistant to races 1 and 3 of the soybean cyst nematode and to the root-knot nematode. Jeff was released as a Maturity Group VI variety with resistance to races 1, 3, and 4 of soybean cyst nematode.

Specific temperature required for classification of Phytophthora rot-resistant genotypes - Stoneville, Mississippi. Soybean cultivars used as differentials to identify Phytophthora rot races were inoculated with various races of the pathogen and maintained in growth chambers at 15, 21, 24, 27, and 32° C. The optimum temperature for expression of resistance or susceptibility appears to be at or near 24° C.

Greenhouse seedling test developed for screening for resistance to stem canker disease - Stoneville, Mississippi. Ten-day-old seedlings were inoculated by inserting toothpicks infested with the pathogen into the hypocotyl of each plant in greenhouse tests. Cultivar reactions were highly correlated between greenhouse tests and both artificially and naturally infected field grown plants, from the range of resistant to highly susceptible.

Low level of enzyme lipoxygenase detected - Stoneville, Mississippi. Approximately 2400 germplasm lines were evaluated for fatty acid content. None was identified as being extremely low in linolenic acid. Two lines have been identified as having a low level of an enzyme, lipoxygenase, which breaks down linolenic acid.

Improvement of soybean oil quality by reducing linolenic acid - Raleigh, North Carolina. High levels of linolenic acid in soybean oil cause undesirable flavor quality. New germplasm has been developed with only one-fourth of the linolenic acid, which would enhance the cost-benefit ratio of processing soybean oil for human consumption.

Genetic control of the fatty acid composition of triacylglycerol - Raleigh, North Carolina. Triacylglycerol is the major component of soybean oil. This storage lipid is composed of a variety of different molecular species. The enzyme system responsible for the synthesis of these species is thought to be under genetic control. Experiments have demonstrated that the types of triacylglycerol species synthesized are also a function of the fatty acid composition of the substrates required in the reaction, diacylglycerol and acyl CoA. Phospholipids are the precursors of diacylglycerol and hence contribute two-thirds of the fatty acids found in triacylglycerol.

Two new early determinate soybean varieties specifically adapted to high yield environments - Wooster, Ohio. Two new semidwarf soybean varieties, Pixie and Sprite, were released for high yield environments where taller varieties

normally lodge. At lower yield levels (<40 bu/A) much of this yield advantage is lost. Semidwarf varieties are recommended specifically for high yield environments (>50 bu/A), in solid seeding (7- to 10-inch rows), and at high seeding rates (225,000 to 300,000 seeds/A or 90 to 120 lb/A).

PEANUTS:

Peanut genotypes resistant to toxin-producing strains of *Aspergillus* spp. colonization - Tifton, Georgia. Several lines from crosses that were selected in an effort to breed resistance to toxic-producing strains of *A. flavus* are in various stages of development for possible release. One line, A7109, has been critically evaluated and found to be equal to the standard commercial variety, Florunner, in chemical, organoleptic, and agronomic performance. In 1980 farmer trials grown under drought stress and abnormally high temperature conditions revealed that both A7109 and Florunner had excessive but equal aflatoxin contamination. This indicated that evaluation other than laboratory screening for resistance may be necessary to prevent contamination under several weeks of field conditions highly conducive to contamination.

Irrigation increased peanut yields and quality under high-temperature moisture-deficient environments - Tifton, Georgia. Heat and drought stress cut yields nationwide. When water was applied by cable-tow irrigation, yields for 15 adapted varieties averaged 6.91 vs. 3.43 mt/ha on light soils at Tifton, and 4.14 vs. 2.76 mt/ha on heavier soils at Plains for irrigated vs. rainfed management, respectively. These data support the accelerated move toward supplemental watering of peanuts in the Southeastern Coastal Plain, where irrigation is available for 50% of Georgia's peanut crop land.

Cylindrocladium black rot-resistant lines identified - Tifton, Georgia. Cylindrocladium black rot (CBR), caused by *Cylindrocladium crotalariae* (Loos) Bell & Sobers, is a devastating disease of peanuts in the Virginia-Carolina area and is increasing in incidence annually in the Southeast. A new technique for screening was devised, and more than a thousand genotypes were evaluated for resistance. Lines with resistance have been isolated and the seed has been multiplied for prospective release early in 1981.

New genetic inheritance model aids in peanut breeding - Tifton, Georgia. Testa color in peanuts has an important subjective influence on market quality, and an understanding of its inheritance is prerequisite to developing varieties acceptable in marketing chemicals. In the second generation, from crosses between pink testae and red-on-white variegated testae, the 9-class phenotypic distribution of 1:2:1:2:4:2:1:2:1 was found. This ratio which is very rarely encountered in plant or animal genetics, occurs where two nuclear loci interact with incomplete dominance for each unlinked gene pair.

Early maturing peanut variety released - Stillwater, Oklahoma. Pronto is an early-maturing, large-seeded Spanish genotype with good shelling characteristics and good production potential, especially under short growing seasons and limited soil moisture. Its earliness should give farmers greater flexibility in adjusting planting and harvesting dates, thus escaping some of the hazards of late spring and early fall seasons. Pronto will allow for the development of double or multiple cropping sequences, and can extend peanut production into areas of the world with short, dry seasons where peanuts have been excluded in the past.

SUNFLOWER:

Tolerance to new disease found - Fargo, North Dakota. *Pseudomonas tagetis*, causal agent of apical chlorosis of sunflower, was found to be seed-transmitted. Several USDA inbred lines were found with high levels of tolerance.

New race of downy mildew discovered - Fargo, North Dakota. A new race of downy mildew appeared that is virulent on all previously resistant genotypes.

Endogenous levels of three oxygenated fatty acids determined - Fargo, North Dakota. Endogenous levels of 12-oxo-phytodienoic acid, 12,13-ketol 18:2, and 12,13-ketol 18:1 were determined in sunflower and corn seedlings. They were low initially, but increased as germination progressed. Levels were higher in the light than in the dark. Hydroperoxide isomerase and hydroperoxide cyclase activities from cotton seedlings are associated with the same protein.

Improved germplasm developed - Fargo, North Dakota. An oilseed germplasm line, RHA 801, for improved yield was released to commercial breeders. It carries dominant genes for resistance to downy mildew, *Verticillium* wilt, and to races 1 and 3 of sunflower rust. Three nonoilseed sunflower maintainer lines and their corresponding cytoplasmic male-sterile lines, with improved yield and excellent rust resistance, were released to private and public plant breeders as parental material.

Resistance to powdery mildew disease found - Bushland, Texas. It was shown that *Helianthus praecox praecox* is resistant to powdery mildew. This is significant because *H. praecox* can be crossed with parental lines for incorporation of resistance into hybrids.

Extensive collection of wild *Helianthus* species continued - Bushland, Texas An additional 445 accessions of wild *Helianthus* species were collected in cooperation with Food and Agriculture Organization (FAO). The collection of 1695 accessions now has all species and subspecies of *Helianthus* and will become the "backbone" of genetic research on sunflower in ARS and other domestic and international agencies.

SAFFLOWER:

Inheritance of phytophthora stem rot resistance in safflower - Beltsville, Maryland. The genetic factors conditioning host resistance were found to be different for different levels of pathogen virulence. This finding has significance for studies pertaining to virulence, inheritance, and nature of disease resistance.

Technological Objective 2: New and improved cultural and management practices that increase oilseed crop yields, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.

Research Locations:

Davis, California
Gainesville, Florida
Urbana, Illinois
West Lafayette, Indiana
Ames, Iowa
Beltsville, Maryland
Stoneville, Mississippi
Columbia, Missouri
Raleigh, North Carolina
Wooster, Ohio
Brookings, South Dakota
Suffolk, Virginia

SOYBEANS:

Nitrogen fixation requires more plant energy than does nitrate metabolism - Urbana, Illinois. Soybeans respired 8 to 12% more photosynthate to symbiotically fix a unit of nitrogen than to incorporate a comparable unit of nitrogen from nitrate, when compared in the seedling stage. This suggests that nitrate-grown plants should retain more dry matter than nitrogen-fixing plants and potentially the nitrate-grown plants should yield more if the photosynthetic process is a primary limitation to production of soybeans.

β -Amylase activity is irrelevant to starch metabolism in the soybean seed - Urbana, Illinois. The starch profiles of starch in soybean varieties Wells, Chestnut, and Altona were examined. All three varieties had similar patterns, but enzyme activity in the three varieties varied greatly. Wells contained up to 300 times more β -amylase than Chestnut or Altona. Consequently, β -amylase activity seems irrelevant to starch metabolism in soybean seeds.

Seed maturation is a distinct phase of seed production - Urbana, Illinois. Freshly harvested seeds or seeds shelled, then dried, were nonviable. Seeds dried in intact pods, even when only 17% of normal size, matured into viable seeds and produced healthy plants. These seeds maintained activity of

various enzymes but gained little soluble protein while air-drying in intact pods. There was a qualitative change in seed proteins associated with maturation. Seeds that matured in intact pods have a greater proportion of protein identified as slow moving bands and have completely lost one fast moving band, as compared with seeds shelled before drying.

Soil compaction increases incidence of phytophthora rot - Urbana, Illinois. In a tillage systems study 11% of Corsoy plants were killed by phytophthora rot in compacted soil field plots, as compared with 2% in noncompacted plots. Root density was reduced 29% by soil compaction.

Combination of solid seeding and semidwarf varieties shows potential for significant yield breakthrough in soybeans - Wooster, Ohio. Either of these factors, solid seeding or semidwarf varieties, has shown the potential of increasing Midwest soybean yields 10 to 20%. When the two factors are used in combination, the potential increase is 30 to 40% over that now obtained by most growers using tall varieties in 30-inch rows. The new semidwarf variety Sprite, when solid seeded and averaged over 3 high-yield locations in Ohio in 1979, yielded 82 bu/A, compared with 49 bu/A for the Williams variety grown in 3-inch rows. The advantage of solid-seeded semidwarf varieties becomes greater as the productivity of the environment increases. At yields less than 40 bu/A, much of the advantage of semidwarf varieties is lost.

Environmental stress can reduce the potential yield advantage from solid seeding - Wooster, Ohio. Moisture or nitrogen stress during the critical pod filling period significantly reduced the yield advantage of solid-seeded soybeans over soybeans planted in 30-inch row spacing. The more equidistant spaced plants in solid seeding depleted the available soil moisture or nitrogen more rapidly than soybeans grown in 30-inch rows, leaving little residual moisture or nitrogen for the critical pod filling period. Plants in 30-inch rows, however, had residual moisture and nitrogen between the rows during this period. This interaction, combined with the higher yield potential of solid-seeded soybeans, explains why the yield of solid-seeded soybeans is reduced under stress much more than soybeans in 30-inch rows.

PEANUTS:

Irrigation doubles peanut yields - Suffolk, Virginia. Rainfall in the 1980 crop growing season was about one-half of normal rainfall. Irrigated corn in a 1980 study yielded five times more than nonirrigated corn (167 vs. 32 bu/A). Irrigated peanuts yielded twice as much as nonirrigated peanuts (4003 vs. 2044 lb/A). Irrigation scheduling was done with a computer model and verified by soil sampling procedures. Because of an increase in crop production costs, irrigation has become an important and necessary part of the overall crop production system. Managing available water resources must be given high priority.

Forecasting Cercospora leafspot of peanut by agro-environmental monitoring - Suffolk, Virginia. Two environmental parameters, temperature and relative humidity, were used to predict when infection of peanuts by the Cercospora leafspot fungi would occur. The disease was controlled effectively by treatment based on disease predictions. The use of this environmental model to predict when fungicide applications are necessary will result in monetary savings to the grower, cause less soil compaction, and most importantly, reduce pesticide pollution.

Use of herbicides to suppress a fungal disease of peanuts caused by Sclerotinia - Suffolk, Virginia. Dinoseb and dinoseb + naptalam, two commonly used herbicides, suppressed Sclerotinia blight of peanuts. These herbicides, particularly dinoseb, significantly reduced severity of disease and increased pod yields when used at concentrations normally recommended for weed control. Because of the nonexistence of peanut varieties resistant to Sclerotinia and efficacious fungicides at the present time, the use of a currently labeled herbicide to suppress Sclerotinia blight in peanuts might gain widespread grower acceptance and would aid in alleviating a serious disease problem.

FLAX:

Growth regulators increase oil content of flax - Brookings, South Dakota. Analyses made on seed samples from trials in 1979 and 1980 confirmed previous results showing that oil content of the seed can be increased by applying a growth regulator to the plant after flowering has terminated. The two chemicals showing greatest promise for increasing oil are chlorflurenol and dichlorflurenol, which belong to a chemical group called morphactins. In 1979 oil content was increased to 45.0% in seed from treated plants, compared with the check level of 42.4%. In 1980 studies chlorflurenol was applied to flax at six different postbloom dates, and oil was increased by treatments as late as 20 days after full bloom. Chlorflurenol, applied postbloom at the rate of 25 g/ha, significantly increased oil content of flax in all of seven trials since 1976, whereas dichlorflurenol gave significant increase in two of six trials.

Growth regulator stimulates division and growth of senescing cells - Brookings, South Dakota. The fact that chlorflurenol applied to plants under field or growth chamber conditions delays the yellowing of leaves normally associated with senescence has been shown in previous studies. Work in 1980 showed that the delay of yellowing is associated with resumption of cell elongation and cell division in leaves and stems of treated plants. Leaf thickness was increased. The increase was due to new cell formation and to enlargement of both new and old cells.

Studies to understand yielding ability in flax - Brookings, South Dakota.

A group of 18 varieties of flax, grown annually at Brookings since 1971, contains high yielding and low yielding genotypes. In an effort to understand these differences in yield potential, growth rates of various parts of the plants of all 18 varieties were measured throughout the 1979 growing season. No single growth component calculated in this work consistently accounted for differences in yield. Comparison of two high-yielding cultivars showed that they arrived at high yields by different growth patterns. These findings delineate the problem facing researchers who are trying to increase yields of crop plants. Causes of high yield potential remain to be uncovered by creative research.

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National Research Program 20090
BREEDING AND PRODUCTION - SUGAR CROPS

This National Research Program involves research in breeding and production of sugarcane, sugarbeets, and sweet sorghum. New varieties, hybrids, and breeding lines are developed to improve yield, pest resistance, and drought, cold, and salt tolerance. Cultural and management practices are developed that will improve sugar and sirup yields and minimize production costs. Plant pathologists, geneticists, physiologists, and agronomists work as teams within commodities, sometimes with State researchers, to accomplish the mission.

Technological Objective 1: Develop new and improved breeding lines and varieties that combine high yielding potential and favored quality characters with better pest resistance, drought-cold-salt tolerance, and adaptation to mechanized culture, harvesting, handling, and storage.

NPS Contact: Howard Brooks

Research Locations:

Salinas, California
Fort Collins, Colorado
Canal Point, Florida
Aiea, Hawaii
Houma, Louisiana

Beltsville, Maryland
East Lansing, Michigan
Meridian, Mississippi
Fargo, North Dakota
Logan, Utah

Examples of Recent Progress:

Sugarbeet:

Fusarium Stalk Blight Resistant Line Improves Sugarbeet Seed Yields -
Salinas, CA. A Sugarbeet breeding line with a high level of resistance to Fusarium stalk blight was developed. The line was selected from an inbred that is widely used as a parent in commercial sugarbeet hybrids. Fusarium stalk blight is a serious disease in the major sugarbeet seed production areas of the United States. The introduction and use of this resistant line should significantly reduce losses from this damaging disease.

Nematode Resistance Transferred to Sugarbeet from a Wild Beet Relative -
Salinas, CA. A self-compatible line fully resistant to the sugarbeet nematode was developed from a cross between sugarbeet and a weed relative of the beet that grows wild in the Canary Islands. When selfed, these plants gave full transmission of resistance to their progeny but outcrosses to sugarbeet gave progenies with less than 50% resistance. Although the transfer of resistance from the weed beet to sugarbeet has not been completed, great progress has been made in finding a control for this destructive pest.

Potential of Sugarbeets, Fodder beets and Sugarbeet X Fodder Beet Hybrids for Alcohol Production - Logan, UT. A large number of replicated field trials with sugarbeet, fodder beet, and sugarbeet X fodder beet hybrids demonstrated that beets have excellent potential as a biomass crop for alcohol fuel production. Good adapted disease-resistant sugarbeet hybrids have a potential of 500 to 800 gallons of alcohol per acre. Several fodder beet X sugarbeet hybrids exceeded sugarbeets in potential alcohol production by 8 to 12 percent. One selection of a fuel beet from a broad base population yielded 13 percent more fermentable sugar than sugarbeet. Non-hybrid fodder beets from Europe do not yield as much fermentable sugar as sugarbeet. Fuel beets could become a good cash crop for the Northwestern United States where sugarbeets were grown before the closing of U & I sugar factories in Utah, Idaho, and Washington.

Pollen Collection and Storage Allows Greater Flexibility in Breeding Program - East Lansing, MI. By collecting sugarbeet pollen and storing it in the freezer, it can be used to pollinate plants which bloom later in the year without the necessity of growing the pollinator plant again. Combining this technique with the use of the genes for annual reproductive growth, male sterile equivalents (BC2 seed) of female maintainer sugarbeet lines can be produced in 2 years instead of the usual 4 years.

"Soil-Free" Sugarbeet Breeding Line Released - Beltsville, MD. A "soil-free" sugarbeet breeding line was released to the industry in 1980 after 12 years of breeding work. Soil-free taproots could reduce the weight and complexity of sugarbeet harvesters and have the potential of reducing losses in storage piles by millions of dollars.

Sugarcane:

High Yield Sugarcane Variety Released - Canal Point, FL. A new variety, CP 72-1210, was released for planting to the Florida sugar industry in the fall of 1980. In the average of 20 replicated yield tests it produced 24% more tons of cane per hectare and 25 and 26% more indicated sugar per hectare at early and late harvests, respectively, than did CP 63-588 (the leading commercial cultivar in Florida). CP 72-1210 had adequate resistance for commercial production to sugarcane mosaic virus, leaf scald, eye spot, rust, and smut. There were over 2400 tons of seedcane distributed to the industry of CP 72-1210, the largest amount of seedcane ever distributed in the years of release for a variety in Florida.

Dramatic Increase in Recoverable Sugar Per Ton - Houma, LA. A statistical study was made on all available sugar production records for Louisiana over a 185-year period. The study indicated that the industry is dynamic and expanding, with ever-increasing production. The number of mills decreased from 1500 to 24; mill production increased from 100 to 20,000 tons of sugar per mill per year. Mill efficiency improved during the 19th century but little improvement could be detected for the twentieth. Improvements in field efficiency are reflected in the increase in yields of cane and sugar per acre. The most dramatic improvement has been an increase in sugar recovered per ton of cane milled, due not to improved mill efficiency but to improved varieties. The recoverable sugar per ton of cane as an average

of all experimental varieties has increased from 7.3 to 12.8% during the history of the Laboratory's variety program. While this increase means that improved varieties provided more sugar at no cost, it also means that breeders now can apply stronger selection pressure for pest resistance and cane yield.

Sweet Sorghum:

Sweet Sorghum Cultivars Warrant Release - Meridian, MS. Two superior disease-resistant and high-yielding sweet sorghum cultivars developed over the last 4 years warrant release for commercial use, Mer. 71-1 for biomass yield and Mer. 76-6 for sirup production. Initial observation and data indicate superiority of F_1 progeny over parents in yield and maintenance of quality factors.

Technological Objective 2: Develop new and improved cultural and management practices to increase sugar and sirup yields, minimize production losses, improve quality attributes, and efficiently conserve scarce resources.

Research Locations:

Salinas, California
Fort Collins, Colorado
Canal Point, Florida
Aiea, Hawaii
Houma, Louisiana

Beltsville, Maryland
East Lansing, Michigan
Meridian, Mississippi
Fargo, North Dakota
Logan, Utah

Examples of Recent Progress:

Sugarbeet:

Beet Western Yellows Found to be a Component of the Potato Leafroll Disease - Salinas, CA. Beet western yellows virus (BWYV) has been isolated from potato stocks affected by potato leafroll from widely separated geographic areas of North America. This work establishes a complex etiology for potato leafroll, thought for centuries to be a specific disease. This finding negates or puts in serious doubt all previous work done on leafroll from the standpoint of indexing, certification, vector relationships, and isolation of seed production areas. The work is probably the most significant accomplishment on this disease since its discovery.

Role of IAA and ABA in Sucrose Translocation and Uptake - Logan, UT. The ability of sink tissues (growth centers or developing organs) to mobilize and absorb assimilates is an important factor controlling economic yield in agronomic plants. This past year progress was made towards understanding the mechanisms controlling mobilizing ability and carbon allocation among developing sinks. Translocated sucrose is actively loaded into sink cells. The loading process is energetically coupled to a K^+/H^+ exchange reaction. Therefore, K^+ and H^+ gradients drive sucrose uptake. The plant hormones, ABA and IAA, play a significant role in regulating the sucrose transport mechanism described. These results explain the known effects of IAA and ABA on sink metabolism and carbon allocation, and will provide a basis for future

research on bioregulation of carbon allocation in agronomic plants. Because new technology was needed in order to measure the endogenous hormone levels involved in regulating carbon allocation, an enzyme-linked immunoassay for quantitation of abscisic acid was developed. The assay is rapid and capable of detecting as little as 20 pg of abscisic acid in plant tissue. This new technique will greatly assist future research on hormonal control of plant growth and development.

Systemic Insecticides Increased Rhizoctonia Root Rot - Fort Collins, CO. A combined analysis of 1979 and 1980 field data showed that phorate and aldicarb significantly increased sugarbeet root rot induced by Rhizoctonia solani. Both chemicals frequently are used to control insects or nematodes in areas of rhizoctonia root rot occurrence. Sugarbeet growers are advised to weigh the benefits of insect and nematode control against potential increases in root rot losses.

Aluminum Compounds Can Replace Lead to Clarify Sugarbeet Extracts - Fort Collins, CO. In experiments incorporating a wide variety of sugarbeet cultivars and agronomic practices, aluminum compounds were shown to be satisfactory clarificants of sugarbeet extracts to be used for sucrose analyses and several other chemical analyses. Because hundreds of thousands of such extract clarifications are made each year in sugarbeet industry and research laboratories, a significant reduction in exposure of workers to potentially toxic lead salts and in the discharge of these environmentally harmful compounds can be achieved by substitution of the environmentally safe, nontoxic aluminum salts.

Invertase Activity and the Microflora of Stored Sugarbeet - Fargo, ND. Bacteria and yeast were observed within root cells. Acid and neutral invertase activity were attributed to the root's microflora and not the sugarbeet based on molecular weights and pH effects on invertase. Therefore, the development of sugarbeet genotypes with inherent low invert sugar accumulation would be predictably difficult. These findings suggest greater emphasis should be placed on determining whether microbial metabolism might be contributing to the accumulation of impurities other than invert sugars during root storage and affecting root susceptibility to storage pathogens.

Irrigation Sprinkler Application of Fungicides - East Lansing, MI. In cooperative investigations with Michigan State University, tests conducted in field plots over a 5-year period have shown good control of Cercospora beticola leaf spot disease of sugarbeet with fungicides applied by irrigation sprinklers. In the 1979 test, Rhizoctonia crown rot disease was also suppressed by this method of fungicide application. Advantages of sprinkler application of fungicides over conventional ground and aerial application methods include: better coverage of the material, particularly on lower portions of plants and undersides of leaves; lower cost of application; lower energy requirements.

Sugarcane:

Potential Sugarcane Diseases Reported in Cuba - Houma, LA. Three diseases, leaf scorch (caused by Stagonospora sacchari), yellow spot (caused by

Cercospora koepkai), and wilt (caused by Cephalosporium sacchari), previously rarely reported diseases from the Western Hemisphere, are present in Cuba, 90 miles away from Florida.

Plant Hormone Increases Sugarcane Profits in Hawaii by Increasing Sugar Yields and Decreasing Fuel Oil Burning - Aiea, HI. Two 1-oz/acre applications of the plant hormone gibberellic acid (GA3) to sugarcane increased crop yields by 5 tons cane and 0.5 tons sugar per acre. The applications cost the producer \$40 per acre for which he or she can expect a return of ten times that amount for increased sugar produced and an increase in fiber yield sufficient to replace 2 barrels of fuel oil in the boiler furnace. Last year, more than 4,000 acres in Hawaii received GA3 to increase sugar profits in the State by \$2 million while saving 8,000 bbl fuel oil.

Isolation and Pathogenicity of the Ratoon Stunting Disease Bacterium - Beltsville, MD. A small, coryneform bacterium was isolated from ratoon stunted sugarcane on cell-free media and was shown by pathogenicity tests and by serological and morphological study to be the causal agent of this major sugarcane disease. All of its known characteristics seem to place this bacterium in the group with plant pathogenic coryneform bacteria. The cultivation of this causal agent will allow rapid progress toward control of the disease through advances in diagnosis, in screening for resistance, and in insight into how losses are caused.

Sweet Sorghum:

New Compound to Identify Insecticide-Resistant Plant - Meridian, MS. Trichlorfon was highly effective for identifying insecticide-susceptible and resistant breeding lines of sweet sorghum. Trichlorfon is much less hazardous to applicators and persons entering the exposed areas than methyl parathion, which was formerly used for identifying susceptible plants.

1980 Releases

<u>Name or designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>Sugarcane:</u>		
CP 72-1210	SEA/AR, Florida AES, Florida Sugarcane League	Higher yield than CP 63-588
CP 72-356	SEA/AR, Louisiana AES, American Sugarcane League	Resistant to Smut and Rust. High ratoon yield
CP 72-370	SEA/AR, Louisiana AES, American Sugarcane League	Resistant to Smut and Rust
<u>Sugarbeet:</u>		
SP 8030-0	SEA/AR and BSDF	"Soil-Free"
EL 45/2	SEA/AR, Michigan AES, and BSDF	Monogerm line
FC 702/6	SEA/AR, Colorado AES, and BSDF	Rhizoctonia-resistant
FC 708 and FC 708CMS	SEA/AR, Colorado AES, and BSDF	Rhizoctonia-resistant male-sterile and maintainer line

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National Research Program 20100

BREEDING AND PRODUCTION - FORAGE CROPS FOR HAY, PASTURES AND OTHER USES, INCLUDING TURF

This National Research Program outlines a research program on crop production efficiency to develop new knowledge and to increase crop and livestock productivity. Forage crops for hay, pasture, silage, and other uses, including turf, and grass and legume seed production represent a resource of major economic significance in the United States.

NPS Contact: G. E. Carlson

Technological Objective 1: New and improved genetic populations, breeding lines, and cultivars of forage crops with improved yield, special use characteristics, quality, pest resistance, and tolerance to environmental stress.

Research locations:

Palmer, Alaska
Tifton, Georgia
Watkinsville, Georgia
Manhattan, Kansas
Lexington, Kentucky
Beltsville, Maryland (PGGI)
Beltsville, Maryland (PPHI)
St. Paul, Minnesota
Mississippi State, Mississippi
Columbia, Missouri
Lincoln, Nebraska
Reno, Nevada
Oxford, North Carolina
Mandan, North Dakota
University Park, Pennsylvania
College Station, Texas
Temple, Texas
Prosser, Washington
Madison, Wisconsin

Examples of Recent Progress:

Drought tolerance of Tifton 44 bermudagrass - Tifton, Georgia. The excellent drought tolerance of Tifton 44 bermudagrass was demonstrated in 1980. Texas reported drought tolerance of Tifton 44 superior to that of Coastal bermuda. Average daily gains and liveweight gains per acre of steers on Tifton 44 in 1980 were 10% and 5% higher, respectively, than in 1979. Corn, peanut, and soybean yields were down about 50% due to the severe 1980 drought.

Dominant rust immunity found in wild pearl millet introduction - Tifton, Georgia. A wild grassy subspecies of pearl millet, introduced from Senegal, was found to have dominant resistance to rust, the major disease on pearl millet in the United States and one of the worst diseases in the world. Germplasm from this wild species is being evaluated further and transferred by our rapid backcrossing method into the best breeding lines. Rust-resistant lines should greatly increase production and the reliability of both grain and forage.

Pearl millet digestibility evaluations improved - Tifton, Georgia. A study with 20 pearl millets compared in vitro dry matter disappearance (IVDMD) of lines and plants within lines at both vegetative and anthesis stages. The millet lines did not differ in IVDMD when sampled at the vegetative stage, but there were differences among plants within lines. At the anthesis stage, there were differences between lines and plants within lines. It should be possible to select for superior plants within lines by using either sampling time. Sampling at the vegetative stage will permit the intermating of high IVDMD phenotypes in a population improvement program. This early sampling will at least double the rate of advance in breeding for improved IVDMD.

New lupine varieties increased - Tifton, Georgia. The Tifwhite-78 and Tifblue-78 lupine varieties released in 1980 did exceedingly well under increase in Georgia in 1980. Work with the seed by Aguilera, SEA scientist at the Food Protein R & D Center, Texas A. & M. University, demonstrated that high protein flours could be made from these lupines that are superior in milling qualities to soybean products for use as protein supplements in developing countries. Research in Brazil and other areas of the world indicate that these Tifton winterhardy lines may extend the value of lupine into areas where lupines currently suffer freeze damage to the extent that other cultivars are not dependable.

Control for peanut mottle virus in blue and white lupine developed - Tifton, Georgia. Peanut mottle virus (PMV) has the potential for being a disastrous disease on both blue and white lupines. We have demonstrated that planting lupines early in the fall (before October 15) following peanuts is the major factor contributing to this disease, and results in over 80% of lupine plants being affected by time of flowering. Where we planted lupine following peanuts on or after November 1, PMV would appear in the late spring but was not a major disease. Thus, most of the damage appears to result from fall infection from young peanut seedlings and secondary spread occurs throughout the winter in lupines. In lupine plantings isolated from peanuts by relatively short distances (200 m), PMV was usually less than 1% at harvest. Therefore, it appears that rotation and date of planting is adequate for control of this potentially devastating disease on lupines.

Gel filtration chromatography effectively evaluates drought stress - Watkinsville, Georgia. A technique that characterizes the distribution of nitrogenous fractions of plants by preparative gel filtration chromatography has been used to evaluate drought stress and N fertilization and interactive effects on tall fescue N metabolism. Drought stress altered the types of N residues and increased the quantities of soluble small peptides and amino acids which

occurred. The technique may permit more comprehensive evaluation of a plant's response to environmental and management stresses.

Perennial and annual alfalfa successfully crossed - Manhattan, Kansas. The first successful cross between an annual and perennial alfalfa was made by utilizing a growth hormone following pollination. Perennial alfalfa (tetraploid *Medicago sativa*) was crossed with annual alfalfa (tetraploid *Medicago scutellata*). The resulting F₁ hybrid is a mixoploid. The initial shoot was hexaploid. A later shoot was tetraploid, and a recent shoot was identified as different by flower color. The ability to make wide crosses will allow resistant genes to be incorporated into commercial cultivars.

An endophytic fungus, perloine, N-acetyl and N-formyl loline alkaloids associated with summer fescue toxicosis - Lexington, Kentucky. Gl-307, a low perloine (an alkaloid that inhibits digestibility in ruminants) strain derived from ryegrass-tall fescue hybrids was found to contain other toxic constituents detrimental to animal performance. A positive relation was shown between *Epichloe typhina* (a seed-transmitted endophyte of tall fescue) infestation; high loline content in seed and forage; and low feed intake and poor performance of young Holstein steers under high ambient temperature stress when they were fed Gl-307 seed and forage. *E. typhina*-infected seed planted in the Oregon Willamette Valley in 1979 produced progenies and seed free of the fungus. A Kentucky 31 tall fescue sod remained free of the disease for 4 years. These findings should permit the development of a low alkaloid cultivar to overcome the fescue toxicosis problem.

Alfalfa strain crosses have the potential to produce greater forage yield - Beltsville, Maryland. When strain crosses were made among high-yielding elite parental lines, yields of resulting populations tended to exceed those of the best parent. This was interpreted as heterosis due to the increased heterozygosity of the resulting populations. Although alfalfa breeders have been aware of the potential for improved yielding ability when strain crosses are used in population development, this example reveals the benefit from such breeding procedures and will likely become a standard method for cultivar development in the future.

A quick method devised to classify isolates of *Colletotrichum trifolii* according to physiologic race - Beltsville, Maryland. Alfalfa clones with resistant (R) and susceptible (S) reactions to race 1 and race 2 of *C. trifolii* have been isolated. Inoculations are made with a 23-gauge needle in suitable internodes. Symptoms can be classified in 10 to 14 days. Susceptible stems form large lesions at the inoculation site and may wilt and collapse. Resistant stems continue growing normally with no lesion development. An intermediate reaction may be seen on some plants. This method provides rapid identification of the race of new isolates and is nonlethal.

Enhancement of biological nitrogen fixation - Mississippi State, Mississippi. *Rhizobium trifolii* strains differed for symbiotic effectiveness on subterranean clover. Poor strains only produced 500 kg/ha/yr dry matter and 45 kg N/ha/yr

compared with 5,000 kg/ha/yr dry matter and 400 kg/N/ha/yr from the best strains. This suggests vast opportunities for increased forage production and N₂ fixation through use of superior strains of rhizobia. (C. Hagedorn, Mississippi State University, Mississippi State)

Dinitrogen fixation efficiency in crimson clover - Mississippi State, Mississippi. Crimson clover, *Trifolium incarnatum* L., inbred lines have been screened for acetylene reduction with a new nondestructive technique. Selected lines produced 20% more acetylene than open pollinated material. Studies have confirmed genetically controlled variation in crimson for N₂ fixation. These studies suggest the potential for significant improvement of crimson clover for N₂ fixation as well as for dry matter yield and root mass. (C. Hagedorn, Mississippi State University, Mississippi State)

Host-plant resistance research in crimson clover - Mississippi State, Mississippi. Screening crimson clover inbred lines for resistance to the head weevil, *Hypera mele* Fab., has identified 11 lines as resistant and 14 lines as susceptible based on seed damage. Clover head weevils were successfully reared from first instar larvae to the adult stage on a wheatgerm-based artificial diet. Reared adults appeared healthy but slightly smaller than field-collected individuals. The capability to rear the weevil will greatly facilitate the screening program and enhance the probability of finding resistant germplasm.

New diseases affecting survival and productivity of pasture legume plants identified in Mississippi - Mississippi State, Mississippi. Producers have frequently encountered problems in keeping clovers established in pastures and in maintaining their high productivity. In recent research by USDA-SEA-AR at Mississippi State University, several important diseases that attack pasture legumes in the South have been identified for the first time. These diseases are considered likely causes for many crop failures that previously could not be explained or accounted for. Resistance to *Phytophthora* in arrowleaf clover has been found through inoculation and screening of large populations. Recognition of specific causes for failures or decreases in productivity of legumes in pastures is essential to the development of new, improved cultivars with increased survival, productivity and N₂ fixation.

Forage yield and quality factors correlated in Climax timothy - University Park, Pennsylvania. Individual plants within certified 'Climax' timothy varied for yield and quality. Forage yield was negatively correlated with in vitro digestibility, protein, phosphorus and potassium, and positively related to percent dry matter. Protein was positively related to phosphorus, potassium, and calcium. These variations showed that there is not only enough genetic variability within a forage grass cultivar that changes could be made by plant breeding, but also that the breeder must select for yield and quality factors simultaneously to avoid an adverse response in one factor by selecting only for the other.

High humidity promotes leaf disease on warm-season forage grasses in Pennsylvania - University Park, Pennsylvania. Leafspot diseases were severe on indiagrass and old world bluestem, and moderately severe on big and little

bluestems in a site in Centre County, Pennsylvania, but were not serious in a Huntingdon County site. The severe natural outbreak was related to increased duration of high relative humidity and dew period, but not to temperatures. These crops must be evaluated under diverse environments in the region under consideration.

Orchardgrass has two kinds of resistance to the purple leafspot fungus - University Park, Pennsylvania. The purple leafspot pathogen, *Stagonospora arenaria*, penetrates orchardgrass leaves through the cells around stomata. Epidermal cells resist penetration by forming barriers of new cell wall material. When penetration did occur, some leaves showed resistance by limiting the size of the lesions. This was associated with formation of purple materials between cells. Breeders should expect that reduced numbers of lesions may be inherited independently from resistance which shows as reduced size of lesions. The fungus also causes tan blightlike lesions as well as typical purple lesions in the field.

Clover cyst nematode found in Pennsylvania - University Park, Pennsylvania. The clover cyst nematode (*Heterodera trifolii*) was identified as a major cause of premature stand decline of red clover in field experiments. This nematode had not been identified as a problem on red clover in Pennsylvania before 1980. Preliminary results indicate that control of the cyst nematode is an important, but not the only, component for increasing stand life of red clover. Resistant plants have been selected for seed increase and further selection.

Improved breeding method for forage crops identified - University Park, Pennsylvania. Second generation progeny test selection was identified as a potential method for effective selection for yield and other traits with low heritability in forage crops. Theoretical evidence indicated that second generation progeny test selection would be more effective than single generation progeny test selection any time the number of individuals per first generation family was greater than six. The advantage of second generation progeny selection increased as heritability decreased.

Buffelgrass germplasm with better cold tolerance found in African collection - College Station, Texas. Buffelgrass is our most valuable species for arid areas with mild winters, but lack of cold tolerance prevents its use in colder areas. Forty accessions collected at high altitudes in South Africa have survived much colder temperatures (12° F) than any previous accession. These are nonrhizomatous plants that apparently have true tissue resistance in the crown area. Hybridization with rhizomatous plants and a combination of cold-resistant tissue and rhizomes is expected to enhance both yield and winter hardiness.

Breeding of apomictic lovegrasses now possible - Temple, Texas. A practical breeding scheme for the apomictic complex of species that includes weeping, boer, robusta, and some forms of lehmann lovegrass has been developed. Because of the predominant mode of asexual reproduction by seed (apomixis) in lovegrasses, researchers have not been able to obtain new combinations of characters for development of new cultivars. Hybridization with rare sexual plants and cytological and progeny tests were used to develop the breeding

scheme. Thus, it should now be possible to combine characters such as winterhardiness and leafiness from weeping, drought resistance and palatability from boer, forage quality and yield from robusta, and establishment ability from lehmann into new and more useful lovegrass cultivars; the presence of facultative apomixis is not a hindrance.

Iron efficiency improves adaptation of weeping lovegrass to calcareous soils - Temple, Texas. Today's weeping lovegrass cultivars are well adapted to acid soils, but are iron-inefficient, become iron-chlorotic, and are low in yield and persistence when grown on calcareous soils. Previous greenhouse research demonstrated seedling differences in iron efficiency. Our field research showed that these differences occurred also in mature plants and were of sufficient magnitude to greatly increase persistence and relative production of efficient selections, compared with inefficient cultivars, grown on two calcareous soils. Iron efficiency could be of economic significance in weeping lovegrass and should be considered in selecting new lovegrass cultivars.

Planting depth modifies seedling growth and performance - Temple, Texas. Planting depth has effects on root growth and seedling performance. In some cases, planting depth determines whether the seminal or nodal roots penetrate more deeply in the soil at 14 days postemergence. Responses of kleingrass seedlings indicate that the emerging shoot is a weak sink for seed reserves, and seedling vigor could be improved by selecting seedling types whose seed reserves are more completely used.

Progeny testing needed to increase Verticillium wilt resistance in alfalfa - Prosser, Washington. Recurrent phenotypic selection from populations and individual crosses among alfalfa clones selected for resistance to Verticillium indicates that resistance levels above that in presently available European cultivars can be achieved if progeny testing is included in at least part of the procedure.

Genes from diploid (2x) red clover transferred to tetraploid (4x) red clover - Madison, Wisconsin. Genes from diploid (2x) red clover were transferred to tetraploid (4x) red clover forms by crossing diploid with experimental tetraploid forms and by relying on the concept of unreduced gametes in the female diploids. Tetraploid red clover produced in Europe has been reported to have greater disease resistance and to yield 10% to 20% more than the counterpoint diploids. The above procedure will allow plant breeders to transfer adopted genes of the diploid type directly to the tetraploid form and thus prevent considerable inbreeding. This sexual procedure will replace the use of chemicals such as colchicine and nitrous oxide to develop tetraploids.

Technological Objective 2: New and improved cultural and management practices that increase forage crop yields, minimize production and utilization losses, improve feed quality, conserve and use scarce resources efficiently, and enhance environmental quality.

Palmer, Alaska
Booneville, Arkansas
Tifton, Georgia
Watkinsville, Georgia
Peoria, Illinois
St. Paul, Minnesota
Mississippi State, Mississippi
Columbia, Missouri
Reno, Nevada
Raleigh, North Carolina
El Reno, Oklahoma
University Park, Pennsylvania
Prosser, Washington
Madison, Wisconsin

Examples of Recent Progress:

Once-daily suckling improves conception rate - Watkinsville, Georgia.

Withdrawing calves from first-, second-, third-, and fourth-calf cows for the first 45 days of the breeding season with suckling occurring once daily improves conception rates in cows and results in earlier estrus. Calf weights were reduced on the withdrawn calves. These calves also experienced significantly higher helminth populations. The technique of once-daily suckling may help overcome generally poor conception rates among young cows. Potential problems of parasites in withdrawn calves had not been previously recognized.

Magnesium supplementation improves conception rate on tall fescue pasture - Watkinsville, Georgia.

When tall fescue pastures fertilized with 224 kg $N\ ha^{-1}yr^{-1}$ were treated with foliar applications of MgO -bentonite slurry during the tetany season, a trend toward improved cow conception rates was observed in each of 2 years. These results suggest that the commonly occurring hypomagnesemia in beef cows grazing cool-season grasses during the tetany season may contribute to lower conception rate and may emphasize the need for adequate Mg nutrition during this period.

Barley revealed to be superior small grain crop emergency forage - St. Paul, Minnesota. The forage potential of barley was found to be superior to that of oats, wheat, or triticale for yield, quality, and chemical and botanical features at six maturation stages. The superior quality as well as yield of nutrients of barley compared with oats could be attributed to the higher proportion of highly digestible inflorescence in the total matter and to less lignification of the leaf blade and sheath of barley. In vitro digestibility of small grain crop forages can range from 80% to 58% and protein can range from 24% to 11% as maturation increases from flag-leaf to dough-stages, even though nutrient yields progressively increase with age. Progressive lignification in the stem accounted for most of the reduced digestibility of the total forage as small grain crops matured, and lignification of anatomical areas of leaves did not change after flag-leaf stage. Regression equations predict digestibility of these forages from their concentrations of acid detergent lignin, acid detergent fiber, or cell walls.

Legumes improve quality of grass pastures - Columbia, Missouri. Red clover and birdsfoot trefoil can be established in sods of the warm-season grasses. These legumes increased total forage production from 3,372 to 5,934 kg/ha and gave a better seasonal distribution of forage production than the grasses grown alone (without nitrogen fertilization). Legumes increased forage digestibility from 1 to 12 percentage units.

Nitrogen fertilizer may intensify antiquality factors in tall fescue - Columbia, Missouri. Tall fescue pastures were fertilized with 0, 141, and 282 kg N/ha and grazed by ram lambs. Overall, lamb gains were 96 g higher during the fall than during the summer. Nitrogen fertilization had no effect on lamb gains in the fall. But during the summer, lambs lost 16 g/day on the pastures fertilized with 282 kg N/ha as compared with an average gain of 13 g/day on the other pastures. Intake of forage was also reduced during the summer. These results show that sheep can be used as test animals to study the summer slump syndrome of tall fescue. Sheep will permit the use of smaller pastures than would be required for cattle grazing experiments.

New grass provides alternative livestock feed - Raleigh, North Carolina. The new forage, Pennisetum flaccidum, continues to produce higher steer daily gains (0.2 to 0.3 kg) compared with a conventional tall fescue-Coastal bermudagrass system. These responses support laboratory quality estimates. P. flaccidum offers producers an improved alternative for midsummer grazing or for use as a stored feed.

Forage legumes are an economical replacement for nitrogen fertilizer for small farms - University Park, Pennsylvania. Forage legumes such as alfalfa, red clover, and birdsfoot trefoil can replace 200 to 300 pounds of nitrogen per acre in production of hay, silage, and pasture. In terms of crude protein, their replacement value is even higher. Thus, at current prices, use of legumes in livestock-production systems can reduce nitrogen-fertilizer costs \$60 to \$100 per acre.

Rapid measurements of forage quality developing - University Park, Pennsylvania. Research on use of near-infrared-reflectance technology has resulted in procedures for determining crude protein, fibrous constituents, moisture, and digestibility of forages in less than 2 minutes per sample. A mobile unit has been developed and tested in a hay market. A national research effort to further test and apply the technology is in progress.

Tissue culture used to study plant disease resistance - University Park, Pennsylvania. Callus cultures derived from a single hypocotyl are composed of a heterogeneous population of cell types. A tissue culture line from Ladino clover propagated under aseptic conditions was tested for its ability to produce a phytoalexin (medicarpin). The amounts of phytoalexin produced varied from 5 to 600 ug/g of callus tissue even though the pieces tested came from a single plant genotype. Thus, callus tissues differed in their ability to express a given gene.

Biochemistry of disease resistance in plants investigated - University Park, Pennsylvania. Mednicarpin biosynthesis in Ladino clover callus cultures was found to be regulated by cellular sulfhydryl (SH) interactions. Callus cultures were tested with compounds that are known to react with chemically unbound groups. These treated cultures responded by accumulating high levels of the phytoalexin mednicarpin. The response could be prevented by first treating the callus tissue with a compound that protects SH groups from SH reagents. These results suggest a mechanism for regulating phytoalexin biosynthesis that can be tested in biochemical experiments.

Meadow voles proving useful in forage research - University Park, Pennsylvania. Meadow voles are being studied as a bioassay of forage quality. Although different species of bacteria occur in voles and in ruminants, the substances utilized and the products formed are very similar. The flora of the vole responds to feeding forages and concentrates in much the same manner as that of ruminants. Volatile fatty acid concentrations, however, more closely parallel those of equines. The vole's protozoan fauna is characteristically rodent in composition. On the basis of microfloral composition, voles are superior to rats, mice, hamsters, or rabbits as models for evaluating livestock feeds.

Seed transmission of Verticillium albo-atrum - Prosser, Washington.

Verticillium albo-atrum was isolated from within and under the seed coat but not from the embryo or cotyledons of alfalfa seeds when the seed was produced on stems which had been injected with the organism just before or within 3 weeks after the flowers were pollinated. Infected seeds were generally smaller, but a low percentage of full-sized seeds also contained the organism. Results from this injection procedure give strong indication that it is possible for Verticillium wilt to be seed transmitted.

New root-knot nematode described - Prosser, Washington. A new root-knot nematode found widespread in the Pacific Northwest (Washington, Idaho, Oregon, northern California) was named the Columbia root-knot nematode, Meloidogyne chitwoodi. It is known to attack widely diverse economic crops such as potato, tomato, wheat, barley, oats, and corn, as well as several weed hosts.

Technological Objective 3: New and improved cultural and management practices that increase forage crop and turfgrass seed yield, reduce production losses, and improve seed quality.

Research Locations:

Palmer, Alaska
Tifton, Georgia
St. Paul, Minnesota
Stillwater, Oklahoma
Corvallis, Oregon

Examples of Recent Progress:

Two-crop alfalfa seed production system - Stillwater, Oklahoma. The two-crop alfalfa seed production system may solve part of the problems associated with low alfalfa seed yields in the southern Great Plains. Alfalfa seed production must be scheduled to meet a set of balancing alternatives if high yields are to be attained. Early pod-set is essential. Late pods contain a high percentage of chalcid-parasitized seed. Therefore, a gain in pod-set (better pollination) is countered by high percentages of the seeds parasitized by chalcid. Chalcid fly populations peak in late July. If the spring cleanup or field preparation for a summer seed crop is scheduled in April, alfalfa will begin flowering in late May and end in July, when chalcid populations are reasonably low. The late pod-set of July usually contain a high percentage of parasitized seed which contribute very little to the total yield. Harvesting the summer seed crop in late July to early August allows sufficient time to produce a late fall seed crop, thus avoiding peak chalcid fly populations in both crops. Efficient crop pollination is inadequate but is essential for maximum yields in both seed crops.

Forage crop seeds survive 19 years of subfreezing storage - Prosser, Washington. Germination percentages of 291 seed lots averaged only 10% less than the original percentages before subfreezing storage. Alfalfa, white clover, and birdsfoot trefoil seed experienced the least loss, whereas brome grass and red clover seed suffered the greatest loss. Original high germination was more important than location of production. Brome grass seed, however, lost germination rapidly over 12 years' storage, even though its original germination was high.

Pesticide residues in alfalfa pollen and nectar - Prosser, Washington. Residues of demeton, trichlorfon, and aldicarb have been found in alfalfa pollen or nectar. However, alfalfa seed yields, number of leafcutter bee cells constructed, percent live bees, percent pollen-balls, and percent chalkbrood appear not to be influenced by the residues.

Technological Objective 4: Turfgrass cultivars and genetic populations with increased pest resistance, tolerance to environmental stress, and improved agronomic characteristics.

Technological Objective 5: Improved cultural and management practices for turfgrasses that reduce the costs of maintenance, increase ground cover value, provide greater persistence, and improve aesthetics.

Research Locations:

Palmer, Alaska
Tifton, Georgia
Lexington, Kentucky
Beltsville, Maryland (PGGI)

Examples of Recent Progress:

Technique developed to inoculate germplasm with Corticium fuciforme - Beltsville, Maryland. Red thread disease caused by Corticium fuciforme is one of the major diseases of turfgrasses under low maintenance in Europe and the United States. This technique will facilitate screening germplasm for resistance and histological studies of pathogenesis.

Technique developed to germinate zoysiagrass seed - Beltsville, Maryland. Vegetative establishment of zoysiagrass normally requires 2 years for complete ground cover. KOH scarification plus light significantly increased rate and percent germination (80% in 15 days). A reduction in time required for establishment would reduce irrigation, fertilizer, and herbicides needed.

First uniform "National Kentucky Bluegrass Evaluation Trials" established. The establishment of 84 cultivars of Kentucky bluegrass at 41 locations in the United States should provide reliable information to consumers on variety performance at less cost to the public.

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
CULTIVAR RELEASED		
<u>Alfalfa</u>		
Perry	SEA-Nebraska AES	Winterhardy and superior yield
GERMPLASMS RELEASED		
<u>Alfalfa</u>		
NCMP1, NCMP2, NCMP10, and NCWMP22	SEA-North Carolina AES	Root disease resistance, diverse genetic background. Resistance to seed production insects.
<u>Red Clover</u>		
WI-1, WI-2	SEA-Wisconsin AES	Combines resistance to four foliar diseases.
<u>Sorghum</u>		
N30, N31, N32, N34, N35, N36, N38, N39, and N40	SEA-Nebraska AES	For grain or forage A and B lines.

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National Research Program 20110

IMPROVED VEGETATION AND MANAGEMENT PRACTICES FOR RANGE

This National Research Program involves research to develop new and improved technology to increase productivity through improved vegetation and management practices for range; to conserve, protect, and improve our Nation's range resources; and to enhance the multiple use of those resources. An interdisciplinary team approach of both Federal and State researchers is dedicated to this effort.

NPS Contact: G. E. Carlson

Technological Objective 1: Acquire, describe, and evaluate new germplasm; and develop and test improved cultivars of grasses, legumes, shrubs, and forbs with increased ease of establishment, productivity, forage quality, persistence, improved seed qualities and tolerance to grazing, and with reduced losses from antiquity constituents, pests, and environmental hazards.

Research Locations:

Tucson, Arizona
Fort Collins, Colorado
Dubois, Idaho
Mandan, North Dakota
Woodward, Oklahoma
Burns, Oregon
Logan, Utah
Cheyenne, Wyoming

Examples of Recent Progress:

Determination of the physiological requirements of flowering for cicer milkvetch - Fort Collins, Colorado. Cicer milkvetch does not flower under the usual greenhouse and growth chamber environments that are conducive to flowering of the more commonly grown forage legumes. Flowering of milkvetch after vernalization at 5° C night/20° C day for 6 weeks under a 12- or 14-hour photoperiod in the laboratory was similar to that of plants that had wintered in the field. Flowering also was influenced by age at time of vernalization and, of course, the photoperiod following induction. These findings permit us to obtain at least one extra seed generation a year.

Seedling vigor of Russian wildrye improved - Mandan, North Dakota. Seed weight and coleoptile length, two highly heritable and easily measured traits, were found to be useful selection criteria for improving seedling vigor of Russian wildrye. Seedling emergence and growth was measured on 30 diverse genotypes and

was related to several morphological traits to identify characteristics that would be useful in developing new Russian wildrye cultivars with improved seedling vigor. Cultivars with improved seedling vigor would increase the use of Russian wildrye, and would help to extend the grazing season and increase the grazing capacity of rangeland in the northern Great Plains.

New range forage plants from the People's Republic of China may find use in the northern Great Plains and Intermountain Region - Logan, Utah. China has a rich store of forage germplasm, but that germplasm has been "locked up" since 1949 and had been inadequately sampled before 1949. A U.S. Germplasm Delegation spent a month in China during July and August 1980 and returned with 200 forage collections plus cereals and vegetables. This delegation was uniquely successful in that (1) it traveled to parts of China (Inner Mongolia, Gansu Province, and Xinjiang Province) not visited by previous teams, and (2) some collecting was permitted in the wild. Climatic conditions and vegetation in Inner Mongolia are similar to those of the northern Great Plains, and the Xinjiang Province in western China is similar to the Intermountain Region. Forages from range sites in China should be well adapted to comparable sites in the United States. This forage germplasm has been placed in the U.S. National Plant Germplasm System, and it will soon be made available to plant breeders.

Agropyron repens (quackgrass), a weedy species has great potential in forage-grass breeding - Logan, Utah. Quackgrass is a species that occurs in all temperate and subarctic regions of the world. Because of its aggressive spreading habit, quackgrass is usually considered to be a weed. Except for that one bad characteristic, quackgrass has many good qualities including: wide adaptation, high productivity, persistence, and good forage quality. The undesirable spreading habit can be reduced or even eliminated by hybridizing quackgrass with species that do not spread. At Logan, Utah, quackgrass has been hybridized with Agropyron desertorum (crested wheatgrass), A. spicatum (bluebunch wheatgrass), A. dasystachyum (thickspike wheatgrass), and several other Agropyron species. Nonrhizomatous plants appear in advanced-generation hybrid populations. Strains are being bred that contain the desirable qualities of quackgrass but lack its strongly rhizomatous habit.

Promising technique for evaluating seedling performance under drought - Logan, Utah. Improved forages for western rangelands must have drought adaptations that allow plants to grow and survive in these drought-limiting areas. Because of the pivotal role that drought stress plays at the seedling stage, forage improvement programs for western rangelands must have screening procedures that are capable of identifying breeding lines with superior drought resistance at the seedling stage. A line source sprinkler irrigation system was developed for use in a greenhouse environment. This greenhouse procedure is nondestructive and can be used to evaluate large numbers of seedlings under a range of controlled drought stress conditions. Because this screening tool imposes a gradient of drought levels and can be used year-round, it has good potential for use in a variety of drought-related research areas.

New introductions of Russian wildrye have potential - Logan, Utah. Russian wildrye strains recently obtained from the U.S.S.R. have shown exceptional

seedling and vegetative vigor on range sites in northwestern Utah. The most promising selections have been made from the Soviet variety 'Bozoisky' and related accessions. Experimental strains developed from these populations are being extensively evaluated for possible release. Preliminary results indicate that this new germplasm will make a major contribution to the improvement of western rangelands.

New range grasses from interspecific hybridization - Logan, Utah. The USDA-SEA-AR and Utah State University recently announced the release of two new germplasms (RS-1 and RS-2) developed from advanced generations of the Agropyron repens (quackgrass) x A. spicatum (bluebunch wheatgrass) hybrid. The new germplasms are expected to provide a valuable source of breeding materials to other scientists interested in developing improved forage grasses. The two strains are characterized by the vigor and productivity of quackgrass and the drought resistance, forage quality, and growth habit of bluebunch wheatgrass. The RS-1 population is essentially a bunch type with little rhizome development; RS-2 has a moderate degree of vegetative spread. The hybrid strains are fully fertile and varieties developed from them will probably be best adapted for range seedings in the 12- to 17-inch precipitation zones and for hay and pasture under irrigation.

Range alfalfa germplasm collection expanded - Logan, Utah. A cooperative effort by SEA-AR and Agriculture Canada scientists resulted in an expansion of the dryland alfalfa germplasm collections. An extensive search for old dryland stands in seven western States and four provinces made more than 200 alfalfa accessions available to breeders who are developing cultivars for range and pasture use. Nodules also were obtained so that appropriate bacterial cultures could be studied in order to maximize the amount of atmospheric nitrogen being fixed and made available to associated plants in pasture seedings.

Alfalfa stands can be maintained through natural reseeding in semiarid pastures - Logan, Utah. A 25-year-old planting of eight alfalfa populations was used to study seed production, seedling survival, and mature plant density in a dryland pasture. Under an early spring grazing management system, the alfalfa flowered and produced an average of 141 seeds per m². Ten seedlings per m² were counted in the spring, and 12 percent of these survived the summer drought. Because mature alfalfa plants usually live more than 10 years, the alfalfa populations can be expected to maintain their present stand densities despite mortality from disease, rodent damage, and environmental stress.

Hybrid grass shows potential for pasture range - Logan, Utah. Agropyron repens x A. spicatum hybrids clipped at frequencies of 1 to 10 weeks recovered more rapidly and produced more regrowth forage than A. intermedium. At 3- and 4-week clipping intervals, the hybrids yielded similarly to Dactylis glomerata, Festuca arundinacea, Bromus inermis, and B. biebersteinii. Except for A. repens, all hybrid grasses contained higher levels of soluble-carbohydrate root reserves than their parents, and showed potential for continued recovery after grazing.

Native legumes fix nitrogen in high altitude rangelands - Logan Utah. Nitrogen fixation rates of native lupine species were measured throughout the 1980 growing season at five sites along an elevational gradient. Sampling locations varied from 1,478 m to 2,713 m on the west aspect of Francis Peak in the Wasatch Mountains of Utah. Plants were sampled weekly to obtain data used to relate drought stress and nitrogen fixation to legume forage yield. These results will contribute to an understanding of the role of symbiotic nitrogen fixation in increasing plant growth and forage yields in semiarid rangelands.

Technological Objective 2: Develop range improvement practices for increasing productivity of rangeland.

Research Locations:

Tucson, Arizona
Fort Collins, Colorado
Dubois, Idaho
Miles City, Montana
Reno, Nevada
Las Cruces, New Mexico
Mandan, North Dakota
Woodward, Oklahoma
Burns, Oregon
Temple, Texas
Logan, Utah
Cheyenne, Wyoming

Examples of Recent Progress:

Summer transplants are successful in southeastern Arizona - Tucson, Arizona. Perennial grasses transplanted in summer (1979 and 1980) have a greater survival rate than winter transplants on upland soils. Species with an 85 percent survival rate, or better, are Cochise, Lehmann (L-28, L-38), boer (A-84, Catalina) and weeping (53-6892) lovegrasses.

Summer planting on abandoned farmland is successful at Papago Reservation - Tucson, Arizona. Direct seeding of blue panicgrass (A-130 and SEA-SDT) was successful on abandoned farmland with summer irrigations of 4, 8, and 10 cm. Lovegrasses can be successfully planted on uplands but will not establish in silty or clayey bottomland sites.

Fertilizer studies on soils collected in creosotebush communities enhance seedling production - Tucson, Arizona. Greenhouse studies show that additions of fertilizer increase the production of perennial grass seedlings on soils collected at four creosotebush sites. Lack of seeding establishment has been attributed to allelopathy. This study shows that nutrient levels are more important than a possible inhibitory agent.

Fire and mowing of sacaton are detrimental to plant growth and livestock gain - Tucson, Arizona. Plant growth was reduced after burning and mowing, but forage volume was increased. Reductions in plant growth on treated areas were reflected in weight gain losses of livestock.

Stand density of perennial grasses is increased on brush control plots - Tucson, Arizona. Seeding of boer lovegrass across tebuthiuron-treated plots increased seedling density by six times over check plots. Seedling density was greater when herbicide rates were below 1.47 lb/A.

Importance of total nonstructural carbohydrates (TNC) in seedling establishment of blue grama - Fort Collins, Colorado. In a combined analysis of four studies (seedling age, defoliation, shade, and recovery from shade), crown weight was not significantly correlated with tolerance of dehydration ($r = 0.16$). On the other hand, percent total nonstructural carbohydrates (TNC) in crowns was significantly correlated with tolerance of dehydration ($r = 0.69$). TNC apparently protected plant tissues from dehydration injury and also contributed directly to growth of adventitious roots. In general, seedlings with high TNC levels are more likely to survive and become established than seedlings with low TNC levels.

Hail is a factor in the spread of pricklypear cactus - Fort Collins, Colorado. Joints or pads of plains pricklypear (*Opuntia polyacantha*) detached and scattered by hail survived 9 months of unfavorable moisture conditions, and then a significant proportion was able to root and become established as new plants when moisture was abundant. At the Central Plains Experimental Range, rooting success of detached joints was 34 and 13 percent, respectively, in two pastures with sparse and moderate amounts of pricklypear. The number of newly rooted plants was 1,400 and 2,400/ha. Thus more new plants were established in the pasture that already had the most pricklypear, even though a lower percentage of the detached joints rooted. Such adaptivity may be one of the reasons why pricklypear is so prevalent and persistent on the Great Plains.

Winter tissue damage and subsequent plant growth related to plant size and seedling morphology - Miles City, Montana. Grass seedlings with more than two leaves going into the winter died, and those having three or more leaves showed little damage. Seedlings would generally reach this size if planted before mid-September. These plants also developed more rapidly the following spring and reduced grazing deferment for stand establishment from two to one full growing season.

Collection and interpretation of data on successional changes provide quantitative information about trend in range condition as affected by livestock grazing management - Reno, Nevada. Methods used for trend analysis since 1973 on three allotments were frequency, basal cover, canopy cover, density, utilization, and precipitation. This approach measures vegetation change and also provides a basis for explaining some of the reasons for change. A large increase in the frequency of sagebrush was explained by a loss of vigor and disintegration of grass crowns during a drought year followed by high-precipitation years favorable for establishment of sagebrush plants.

Future range trend will depend upon whether grasses or shrubs become dominant. A quantitative measure and interpretation of trend is essential to evaluate whether grazing management plans developed by agencies, through the environment process or by ranchers, through the Experimental Stewardship Program, are actually improving range conditions.

Germinable seeds and periodicity of germination in annual grasslands of California - Reno, Nevada. Few germinable seeds (mostly exotic annual legumes) were carried over from year to year. Dominant annual grasses had virtually no annual carryover. Through the fall, each species exhibited its own pattern of increased germinability, which was highly dependent on its inherent afterripening requirements. In years when the initial fall rains resulted in simultaneous germination, the flush of germination began within a week, and by 5 weeks, the reserve of germinable seeds was largely exhausted. When the communities were subjected to 2 years of extreme drought (1975-76 and 1976-77), established seedling density and subsequent seed reserves dropped dramatically; species composition, however, remained relatively stable. Near-normal moisture conditions in 1977-78 resulted in near-normal communities. Annual grasslands are resilient to drought even though each year's vegetation is wholly dependent on seed germination and seedling establishment.

Soil movement in mesquite sand dunes - Las Cruces, New Mexico. During the 47-year period, maximum deposition was 78 cm and maximum removal in excess of 62 cm. A minimum net loss of 4.6 cm of soil depth occurred. This indicates mesquite sand dunes are not stable. Efforts should be made to control mesquite and halt erosion.

Plant phenology and precipitation - Las Cruces, New Mexico. Detailed phenological observation of 15 species of grasses, forbs, and shrubs showed that the amount and timing of summer precipitation is the major factor controlling the timing and magnitude of expression of growth and reproductive phenophases in the majority of the species. If a method can be devised for scoring precipitation events as to effectiveness in promoting plant growth, precipitation-based models can be developed that would be able to predict end-of-season development of forage species.

Evaluation of herbicides for brush control - Las Cruces, New Mexico. A number of herbicides were aerially applied to 5-ha plots 1977-80. The plots infested with honey mesquite treated with 0.6, 1.5, and 2.2 kg/ha active ingredient of tebuthiuron pellets in 1978 had plant kills of 55, 74, and 81 percent, respectively. From the combined data collected in 1978 and 1979, it appears that 0.6 to 1.0 kg/ha of tebuthiuron would provide an effective control of honey mesquite on sandy soils. The plots infested with creosotebush and tarbush treated with 0.3, 0.4, and 1.3 kg/ha of tebuthiuron in 1978 had kills of 37, 88, and 98 percent, respectively. The combined data for 1978 and 1979 indicate 0.3 to 0.4 kg/ha active ingredient of tebuthiuron would provide an effective control of creosotebush and tarbush.

Impacts of grazing management systems on watersheds - Las Cruces, New Mexico. Deferred-rotation systems increase infiltration rates and decrease runoff and

sediment production compared with continuous grazing at comparable stocking rates. Short-duration grazing systems do not increase infiltration rates and decrease runoff and sediment production. Deferred-rotation grazing systems were as favorable for improving watershed values as the exclusion of livestock grazing in some situations.

Evaluation of rangeland treatments - Las Cruces, New Mexico. Treatment of arid rangeland is important in a rehabilitation program to reduce competition, regulate runoff, reduce sediments, and improve water quality. Significant reductions in surface runoff have been achieved by pitting and rootplowing. Temporal comparisons in 1980 between 1972 and 1976 rootplowed and seeded treatments with a sprinkling rainfall simulator indicated that for dry antecedent soil water conditions, rangelands treated in 1972 had greater infiltration than those treated in 1976.

Root respiration of range plants - Las Cruces, New Mexico. The development of an analytical system to measure root respiration in situ has allowed us to test several hypotheses concerning root respiration in a field situation on attached roots. Root respiration measurements of hydroponically grown plants appear to be two to four times the rates of field plants. Roots from hydroponically grown plants are highly branched and almost entirely nonsuberized. Roots of field-grown plants are not highly branched (few tertiary roots); and on a weight basis, most are suberized with very low respiration rates. The inability of modelers to incorporate previous root respiration data into models may be explained on the basis of growth medium and morphology of the two root types.

Crested wheatgrass yields are greater than yield from native range - Burns, Oregon. Mean yield of crested wheatgrass over a 29-year period was 8 percent greater than the yield of a native range free of brush. The native range mixtures also include undesirable forage, such as cheatgrass and unpalatable broadleaves; thus, the advantage of crested wheatgrass seeding as a forage producer for the grazing animal is further increased. This information is helpful in today's cost-benefit analyses of EIS's now mandated by law and in dispelling the concept that "native is best" in all aspects.

Burning sagebrush successfully and safely - Burns, Oregon. Sagebrush burns are a function of brush cover, herbaceous fuels, air temperature, relative humidity, and wind. Based on numerous field fire trials, the proportions of herbaceous fuel and of brush canopy cover, where successful burns can be expected, for nominal weather conditions have been described. This relation will assist those selecting sites for improvement by burning.

Evaporation losses can be minimal - Burns, Oregon. Floating foam rubber sheets on the surface of small precipitation catchments was most effective in reducing summer evaporation loss. These results in the Pacific Northwest support the research findings in the Southwest that foam rubber floats can be an effective and practical means of reducing evaporation loss on small catchments.

St. Helens' ash: a new addition to the range - Burns, Oregon. Chemical and physical analyses of the ash suggest no toxic levels or any strong fertilizer

enhancement impact. Water infiltration on native range was improved with surface additions of the sand-like Yakima ash but was reduced with surface additions of the finer, silt-like ash from Moses Lake. Potential sediments in runoff from the silt-like ash were much greater than from the sand-like ash and may constitute a problem to the environment. Seed germination on, in, and under the ash layer was only slightly reduced as compared with germination in mineral soil. In vitro digestion of forages was not significantly affected by ash additions to the substrate. High levels of ash additions directly into the rumen did not greatly alter the animal's performance.

Grass establishment - Temple, Texas. Seeds germinated before planting in the field resulted in the establishment of more seedlings than did untreated seeds. This verifies greenhouse work. Field research also demonstrated that transplants grown in bandoleers could be planted with or without a plastic wrapper on the root plug with no difference in performance. Because it is easier to design machines to handle bandoleer plugs, this finding will simplify the development of high-speed transplanting machinery. An automatic feed system was developed for the transplanter to handle grass seedlings grown in bandoleers. Shop tests of the machine proved that the mechanism works. This was a significant step forward toward a total system for transplanting grass.

Technological Objective 3: Develop grazing (forage-livestock) management systems which convert range forage more efficiently to animal products and are consistent with improvement, conservation, and multiple use of range ecosystems.

Research Locations:

Fort Collins, Colorado
Dubois, Idaho
Miles City, Montana
Reno, Nevada
Las Cruces, New Mexico
Mandan, North Dakota
El Reno, Oklahoma
Woodward, Oklahoma
Burns, Oregon
Cheyenne, Wyoming

Examples of Recent Progress:

Electronic sensing of range cattle - Las Cruces, New Mexico. Individual cattle weight change, their subdermal body temperature, and frequency to enter a drinking water location can be obtained automatically at remote sites despite extreme temperatures, dust, and fluctuation in battery power. The data acquisition was made possible with an electronic identification, subdermal body temperature sensing unit that was interfaced with a single animal electronic

scale. Continuous, computer-compatible data can be obtained without transcriptional and phonetic errors. When the system becomes commercially available, increased livestock production at a lower cost will be possible.

Cattle gains on crested wheatgrass and irrigated alfalfa-brome pastures related to grazing pressure - Cheyenne, Wyoming. In 1979 and 1980, crested wheatgrass dryland pastures and alfalfa-smooth brome grass irrigated pastures were stocked at 0.30 to 0.40 and 0.25 to 0.85 AUM/T of forage produced. Daily gains of cows, heifers, and calves declined linearly with increasing grazing pressure. With each additional 0.1 AUM/T of forage on alfalfa-brome, cow, heifer, and calf gains declined 0.58, 0.25, and 0.19 lb, respectively. On crested wheatgrass, cow, heifer, and calf gains declined 2.07, 1.13, and 0.22 lb, respectively. This relationship can be used by livestock producers to estimate suitable stocking rates for their pastures.

<u>Name or Designation</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
CULTIVAR RELEASED		
Monarch Cicer Milkvetch	SEA-Colorado and Colorado AES	Improved seedling vigor and ease of establishment.

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National Research Program 20160

INTRODUCTION, CLASSIFICATION, MAINTENANCE, EVALUATION, AND DOCUMENTATION OF PLANT GERMPLASM

Research is directed to provide breeders and other applied plant scientists with the genetic resources needed for improving crop plants in terms of their reaction to environmental stresses such as insect and disease pests, adverse weather, and moisture supplies, and in terms of compositional characteristics and nutritional factors. It also provides for a continuing evaluation of new plant resources that have the potential of becoming viable new crops which can provide raw materials needed for changing industrial and medical technologies or to meet national requirements for strategic materials.

NPS Contact: Quentin Jones

Technological Objective 1: Expanded collections and improved maintenance, evaluation, and distribution of plant germplasm as sources of useful genetic material to improve existing crops and developing new crops.

Research Locations:

Davis, California
Indio, California
Fort Collins, Colorado
Washington, D.C.
Miami, Florida
Experiment, Georgia
Savannah, Georgia
Ames, Iowa
Beltsville, Maryland
Glenn Dale, Maryland
Geneva, New York
Mayaguez, Puerto
Pullman, Washington
Sturgeon Bay, Wisconsin

Selected Examples of Recent Progress:

Free-living date palms from frozen tissue - Indio, California. Development of free-living date palms from frozen tissue provides evidence that cryogenic storage of date palm tissue may in the future be a valuable adjunct to maintenance of the date germplasm collection.

Exotherms (killing points) vary for dry and moist seeds - Fort Collins, Colorado. For cryogenic storage of plant germplasm as viable seeds, it is necessary to know at what temperature seeds with various moisture contents undergo freezing damage. Exotherms vary for dry and moist seeds. For the species tested no exotherms were observed for seeds below the critical moisture content which ranged from 9.3 for

sesame to 27.2 for snap beans. For seeds with moisture contents above the critical level exotherms varied from -7°C for wheat to -28°C for cabbage, with exotherms for most kinds of seeds studied in the range between -21°C and -28°C .

New ornamental released for indoor houseplant - Miami, Florida. Chrysothemis pulchella 'Amazon', P.I. 424916 was collected in Belem, Para, Brazil, in 1978. It is a low herbaceous perennial that is recommended for use as a container-grown ornamental under conditions where Episcia and other warm-climate Gesneriads thrive. It can also be used as a summer ground cover outdoors in Florida where it grows and blooms equally well in sun or shade. The best features of 'Amazon' are the large bright yellow flowers and orange-red calyces, borne year-round. The leaves, decorative in themselves, are bronzy-green above and purple underneath. It is easily propagated in greenhouses under conditions similar to those for propagating African violets.

Plant Introductions make important contributions to breeding progress - Miami, Florida. Mango selection M-25839 showed outstanding anthracnose resistance in field and laboratory for the second consecutive year. Two avocado selections (M-26395 and 27128) show promising cold tolerance and fruit quality. Laboratory work confirmed field resistance to anthracnose observed in lychee, with 'Peerless' (P.I. 277274) showing greatest external resistance of uninjured peel, and 'Mauritius' (P.I. 277473) the least. Eight of 15 fruiting lychee seedlings were selected for further evaluation. Fruiting of only 3.3 percent of a 20-year seedling population may indicate that Litchi shows prolonged juvenility, as does Citrus. Outstandingly productive seedlings appeared from self-pollinating and crossing self-compatible lines of yellow passion fruit. A purple passion fruit line collected wild in Brazil showed unexpected self-incompatibility homologous to that common in yellow passion fruit. Colchicine treatment of hybrids between Passiflora coriacea and P. suberosa increased pollen size and fertility. Seedlings from crossing Rubus niveus (a tropical black raspberry) with a fall-bearing northern cultivar appeared to be true hybrids developing normally. Dwarf seedlings of lingaro (Elaeagnus philippinensis) remained so after a season in the field. Three Argentine Eugenia introductions (E. myrcianthes, E. pitanga, and an undetermined species) promised a high degree of cold resistance. Two citrus introductions, 'Mateira' mandarin and 'Coorg' lime, were prepared for release to the public.

Development of evaluation data file for wheat collection - Beltsville, Maryland. There are now 318,000 records in the wheat evaluation data file, which document 36,000 wheat accessions in the USDA Small Grains Collection. There is information for 106 different descriptors, most of which are reactions to diseases or insects. The unique features of this file are that the source of each datum is maintained, a coded value for the evaluation is stored to permit selection of accessions for desirable traits, and a decoded value is also kept so that the criterion of the original evaluation is available to the user of the system.

Speeding seed production of biennial crops - Geneva, New York. Through experimentation we have learned how to shorten the time from seed planting to seed harvest of biennial vegetable crops. This involves exposing the young plants (when 8 to 9 inches tall) to a cold treatment (60 to 70 days at 45 to 50°F) and then transferring them to the greenhouse for growing the seed crop.

Timothies with high ammonium nutrition tolerance may reduce cost of fertilization - Geneva, New York. Selection of individual plants of timothy grass showing tolerance

for high ammonium nutrition may result in savings for farmers. Since the cost of ammonium nitrogen is cheaper than the nitrate form, timothies tolerant to high ammonium nutrition can result in savings for farmers who wish to use the ammonium form of nitrogen, particularly as many of these selections tolerate as much as 25-35 percent of their nitrogen in the ammonium form.

Collection of native rhododendrons and azaleas helpful in potential for cold acclimatization - Geneva, New York. Native azaleas and rhododendrons collected from the coldest location where each of eight indigenous species was growing in natural stands have been assigned PI numbers and are available to arboreta and experiment stations for use in breeding programs and other evaluations. If any of these collected plant materials prove to have increased cold hardiness, cold acclimatization of these populations may result in wider growing areas. Seedlings of 55 collections are being grown at the University of Vermont and will be evaluated for growth rate, cold hardiness, ornamental qualities and pest problems. In laboratory cold hardiness studies a comparison will be made of the rate of cold acclimatization of these populations.

Forage collections from the USSR are made available to plant breeders - Logan, Utah. A USDA-sponsored plant exploration to the USSR in 1977 netted 1,100 collections, most of which were forage plants. The entire collection was grown at Logan, Utah. In the spring of 1980, the North American Grass Breeders Conference was held at Logan and attracted about 100 plant breeders from Federal, State, and private institutions. The breeders were taken through the USSR forage collection and invited to select plants from which they desired seed. Several hundred seed collections have since been sent to those breeders, and the collections are now being widely used by public and private breeders.

Plant Introductions make important contributions to breeding progress - Experiment, Georgia; Ames, Iowa; Geneva, New York; and Pullman, Washington.--Described below are examples of PI's, as reported by cooperators, that are considered to have made important contributions to plant breeding progress and to U.S. agriculture.

- PI 294484 (Eragrostis curvula) from South Africa was released as 'Renner' weeping lovegrass. 'Renner' is adapted to southern Oklahoma and the eastern half of Texas.

- 'Monarch' cicer milkvetch (Astragalus cicer) was registered in 1980. Ten of the parental clones trace directly or indirectly to PI 66515. Also included in its parentage are PI 133142, PI 206405, and PI 246727.

- 'Covar' sheep fescue (Festuca ovina var. ovina) was registered. 'Covar' originated from PI 109497, collected in Turkey, and was developed for areas subject to soil erosion in the Pacific Northwest.

1/ A more complete listing can be obtained from the minutes of the annual technical committee meetings of the four Regional Plant Introduction Station Projects W-6, NC-7, S-9, and NE-9.

● Bean germplasm exhibiting tolerance to Pythium ultimum root rot under controlled conditions was selected from PI's 125836, 167349, 169716, 169787, 169912, 203958, 204718, 204722, 205207, 205211, 222738, and 222819.

● Wheat grass, Agropyron intermedium, introductions PI's 345586, 273732, 273733, and 315355 were found to be equal or superior to the cultivar 'Slate' in first-year growth and to exceed Slate's second-year mean yield of forage.

● Selections from 14 safflower (Carthamus tinctorius) introductions were resistant to Fusarium wilt.

● Germplasm derived in part from PI 232123 was included in interspecific hybrids of Agropyron repens (quackgrass) and A. spicatum released by the Utah Experiment Station and USDA-SEA-AR. This germplasm was adapted for range seedings in the 30 to 45 cm precipitation zones and for hay or pasture under irrigation.

● Resistance to seedcorn maggot was found in bean (Phaseolus vulgaris) introduction PI 165426.

● PI 269324, a yellow-seeded garden type bush snap bean from Sweden, was found to have resistance to both Fusarium solani f. sp. phaseoli and to Pythium ultimum, although it was susceptible to bean common mosaic virus.

● Phaseolus coccineus lines showing white mold resistance are PI's 417586, 417590, 417593, 417604, 417605, and 417607.

● Bean (Phaseolus vulgaris) PI 150414, which shows resistance to race 1 and 2 of Pseudomonas phaseolicola, was found through comparative electrophoretic studies to lack a specific albumin protein present in susceptible varieties.

● A source of resistance to widespread and severe mosaic caused by cucumber mosaic virus on late summer-grown lettuce in New York State was found in PI 261653, an accession of Lactuca saligna from Portugal.

● Breeding line B4175 is a newly-released bush snap bean (Phaseolus vulgaris) with root-knot nematode resistance derived from PI 165426.

● Lactuca sativa PI 167150 was one of the parents of 'Signal' lettuce, a high-quality cos type adapted to the desert Southwest.

● PI 195342, a pole-type lima bean from Guatemala with resistance to races A, B, and C of downy mildew, was one of the grandparents of the recently registered B2C lima bean germplasm.

● Safflower (Carthamus tinctorius) germplasm lines UC-148 and UC-149 segregating for genetic male sterility were released by the California Experiment Station and included PI 253914 (from Afghanistan) and PI 34088 (from Turkey), respectively, as parents.

● Wisconsin (BBSR) 17 and 28 snap bean breeding lines resistant to Pseudomonas syringae include PI 313537 in their ancestry.

■ Two Red Mexican Bean cultivars, NW-59 and NW-63, which included PI 203958 in their parentage and are immune to the prevalent type and New York 15 strains of bean common mosaic virus and curly top virus and which combine early maturing short plant type with resistance to Fusarium root rot, were developed in Washington.

■ PI 203958 was a parent of the newly-released pinto bean cultivar, NW-590. NW-590 meets the need for early maturing, shorter-vined pinto beans with increased virus and Fusarium resistance.

■ Seven new crisphead lettuce cultivars, Alamo, Anza, Laguna, Ramona, Rita, Vega, and Vista, which derived resistance to U.S. race 5 of downy mildew from PI 177418 and PI 91532, were released to commercial seed growers in the California production districts.

■ The winterhardiness of 53 limpograss (Hemarthria altissima) clones was tested at 24 locations. Considerable genetic variability was found, indicating that winter-hardy germplasm might be used to expand the production range and extend the effective grazing period of this pasture grass.

■ Evaluation of 25 alfalfa PI's for resistance to six isolates of Phytophthora megasperma identified possible new sources of resistance and also provided material useful in inheritance studies. PI's 299046, Medicago coerulea from Greece and 377727, M. varia from USSR had 26 and 21 percent resistant plants, respectively.

■ Alfalfa PI 325412 from USSR has some tolerance to Phytophthora root rot. It is also being evaluated for winterhardiness in Western Canada.

■ Significant differences were found in 49 brome grass (Bromus inermis) introductions for all traits evaluated which included forage yield, in vitro dry matter determination (IVDMD), crude protein, and panicle and canopy height. PI's 315374, 315378, 315398, and 315237 had forage yields similar to the cultivar 'Lincoln', but were significantly higher in first cut IVDMD and should be useful germplasm in breeding for high IVDMD.

■ Corn PI's 217414 and 217415, both cultivars 'Drought Proof Yellow Dent' from West Virginia, were used to provide drought tolerance in inbred lines and hybrids. Grown under dry-land conditions in Nebraska, both populations appeared to have good drought tolerance and silked and shed pollen well even during periods of heat stress.

■ PI 217404, 'Argentine Pop', a small-eared, tiny-kerneled, prolific corn variety from the Argentine is showing resistance to "eyespot" caused by Kabatiella zeae and is being used in the breeding program at Iowa State for this trait.

■ Corn PI's 340851, 340856, and 340866, all popcorns with colored pericarp developed from open pollinated varieties at Iowa State University, were found to be tolerant to Leaf Freckles and Wilt (LFW) at Nebraska. It is anticipated that the material resistant to LFW bacterium will be used in breeding popcorn.

SUMMARY OF PLANT GERMPLASM
INTRODUCTION AND USE
1980

	<u>Acquired in CY 1980</u>	<u>Currently held</u>	<u>To users</u>
<u>Principal Centers:</u>			
Office of Plant Introduction, Beltsville, MD			
Foreign Exchange	15,081 ^{1/}	<u>2/</u>	102,932
Domestic Exchange			1,258
National Seed Storage Laboratory, Fort Collins, CO			
Base Collection, Long-term	8,704	117,742	1,730
<u>Working (Active) Collections:</u>			
Regional Plant Introduction Station, Experiment, GA	3,513	39,845	18,757
Regional Plant Introduction Station, Ames, IA	750	22,000	20,815
Regional Plant Introduction Station, Geneva, NY	550	15,500	7,749
Regional Plant Introduction Station, Pullman, WA	3,034	26,524	14,410
Subtropical Horticultural Research Station, Miami, Florida	736	5,430	2,984
Small Grains Collection, Beltsville, MD	1,322	85,000	98,970 ^{3/}

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- ^{1/} In addition, 28,962 items (including 500 Solanum lines from Peru and 774 sorghums from IBPGR/FAO for the NSSL) were received, some of which will eventually be assigned PI numbers.
- ^{2/} The Office of Plant Introduction does not "hold" germplasm, rather it provides a national focal point and clearing house for exchange of plant germplasm with foreign countries.
- ^{3/} Of this number 33,370 were sent to domestic users and 65,600 to foreign countries. These foreign exchanges were handled by the Office of Plant Introduction in addition to the 102,932 exchanges listed above.

Technological Objective 2: New and improved knowledge of the chemical, biological, and agronomic potentials of selected plant species as new crop sources of industrial oils, waxes, gums, fibers, of food and feed proteins, and licit and illicit narcotic drugs and other medicinals.

Research Locations:

Flagstaff, Arizona
Savannah, Georgia
Bloomington, Indiana
Peoria, Illinois
Ames, Iowa
Beltsville, Maryland
Corvallis, Oregon
Islamabad, Pakistan
Philadelphia, Pennsylvania
Mayaguez, Puerto Rico
College Station, Texas
Chiang Mai, Thailand
Pullman, Washington

Selected Examples of Recent Progress:

Quantitative HPLC of carbonyl-containing lipids - Peoria, Illinois. The separation and quantitation of fatty acid, mono-, di- and triglyceride mixtures have been accomplished by high performance liquid chromatography (HPLC) by using gradient elution and infrared detection of the carbonyl functionality. This technique replaces older, more time-consuming methods and provides a means of quantitating other carbonyl-containing entities in seed oils directly without prior isolation or derivation. This development has applications beyond the analysis of seed oils in such areas as natural products, emulsifier additives, and food chemistry.

Taxanes from *Taxus wallichiana* - Peoria, Illinois. Six new cytotoxic substances of the taxane series have been isolated from *T. wallichiana* and characterized. These compounds are structurally related to taxol, a leading contender among compounds under consideration for cancer chemotherapy. However, they represent different functionalization of the taxane system with a range of polarities that may extend the chemotherapeutic usefulness of this class of compounds.

Capacity of cultured *P. somniferum* cells to synthesize alkaloids studied - Bloomington, Indiana. Callus tissues showed different capacities to produce alkaloids; most hormone combinations resulted in thebaine production, but some resulted in codeine synthesis as well as thebaine, with codeine representing a high percentage of total alkaloids present. No morphine was formed in callus. Derived meristemoid, and roots, produced only thebaine. Cultures with redifferentiated shoots synthesized morphine, as well as codeine and thebaine. Alkaloids were identified by mass spectrometry. The nature of the medium, therefore, can influence the alkaloids formed in callus (thebaine vs. codeine), but a high degree of tissue organization and redifferentiation (shoots) appears necessary

for morphine synthesis. Quite possibly morphine synthesis characterizes a capacity of the laticifer as a cell type.

Seed protein studies contribute to the taxonomy of Cannabis sativa (Cannabaceae)-Bloomington, Indiana. Soluble seed protein profiles of ungerminated achenes of C. sativa (marihuana) were compared by SDS acrylamide gel electrophoresis. The achene samples consisted of 23 seed sources of worldwide distribution selected to encompass a range of known intoxicant, semi-intoxicant, and nonintoxicant groups. Electrophoretic banding patterns compared visually and by densitometer tracings revealed a highly similar profile in terms of band number, band position, and band density among all seed sources regardless of country of origin or drug grouping. These data are interpreted to support the concept of a monotypic genus for Cannabis.

Eleven new chemicals show potential for control of narcotic plants - Beltsville, Maryland. Eleven of 16 chemicals included in the 1979 field evaluation studies were selected for evaluation of their potential as postemergence treatments for controlling marihuana and opium poppy. Five new chemicals successfully controlled greenhouse-grown marihuana and seven new chemicals successfully controlled greenhouse-grown opium poppy. Several candidate herbicides were selective in action. Potential consideration of the use of these materials for the control of narcotic plants is, in part, contingent upon the development of them by industry.

Forty thousand achenes from Stokesia laevis populations screened - Beltsville, Maryland. Approximately 40,000 achenes from Stokesia laevis populations were screened for nondormancy and seedling vigor and 8,000 from the late flowering populations were selected and established in the field for agronomic evaluation. Seedling vigor was still quite low in the early flowering populations and further screening will be conducted before field evaluation can commence.

Mosses screened for antitumor activity - Beltsville, Maryland. For the first time, mosses were intensively collected for screening in the cancer screening program. Bulk samples were collected in Eastern and Western United States for submission to the National Cancer Institute. Significantly, one moss, Cladodium, was found to have interesting anticancer activity.

Computerized index to Chinese medicinal plants - Beltsville, Maryland. The largest extant computerized English-language index to folk-medicinal plants of China has been developed. This lists some 10,000 folk medicinal applications of some 3,000 Chinese species, many of which we hope to procure for screening against test-tube cancers. Data were collected bibliographically and computerized with on-line TSO operation. This computer program has helped open the doorway to our peers in the Peoples Republic of China. Chinese materials are finally being brought into our cancer screening program.

Chemicals applied to poppy plants reduce harvestable alkaloids - Philadelphia, Pennsylvania. Sodium sulfite, diethyldithiocarbamate and ethephon modify the chemistry or physiology of the poppy plant (Papaver somniferum) and greatly reduce the amount of morphine that can be obtained from the plant. Sodium sulfite and diethyldithiocarbamate inhibit enzyme systems necessary for alkaloid production; ethephon promotes abscission of flower buds from the stem and causes buds to atrophy without flowering and forming capsules.

New procedure developed for production of somatic embryos of opium poppy - College Station, Texas. A new procedure has been developed for the production of somatic embryos of opium poppy, Papaver somniferum L., in tissue culture. Previous experiments with various combinations and concentrations of growth regulators have yielded low rates of root and shoot regeneration from callus. The new technique allows for the culture of somatic embryos that can be directly regenerated into plantlets. Plantlets obtained in this manner have continued to grow when transferred to soil. Morphological and anatomical investigations of somatic embryogenesis in P. somniferum are currently in progress.

Technological Objective 3: Increased understanding of the taxonomic relationships, geographical and ecological distribution, and centers of diversity of crop plants and their wild relatives to promote the systematic assembly of germplasm for crop improvement.

Research Locations:

Washington, D.C.
Beltsville, Maryland
Islamabad, Pakistan

Selected Examples of Recent Progress:

The tribe Alyseae (Cruciferae) as hyperaccumulators of nickel - Washington, D.C. (National Arboretum). Within the tribe Alyseae, 45 species of Alyssum (Sect. Odontarrhena), the four known species of Bornmuellera, and the monotypic genus Leptoplax have been identified as active hyperaccumulators of nickel, each yielding more than 1,000 ppm of nickel dry mass. Some other members of Alyseae, including one species of Buchingera and two of Physoptychis contain normal toxic values of nickel, i.e. 150-680 ppm. The nickel accumulator species thus far recognized are indigenous to the Mediterranean or Irano-Turanian floristic regions and all grow on serpentine ultra-basic substrates.

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National Research Program 20170
PHYSIOLOGICAL AND BIOCHEMICAL TECHNOLOGY TO IMPROVE CROP PRODUCTION

National Research Program 20170 involves research elucidating the basic function of plants at the physiological and biochemical level. New data yielded by this research will establish advanced agricultural technology focused on field and horticultural crops. Among the major emphases of this National Research Program are photosynthetic efficiency and biological conversion of solar energy by plants; biological nitrogen fixation and utilization of nutrients; environmental stress damage to plants; and molecular biology to increase crop production efficiency.

NPS Contact: Howard Brooks

Technological Objective 1: Improve biological conversion of solar energy for increased crop production by increasing the efficiency of photosynthesis, translocation, and associated metabolism.

Research Locations:

Albany, California
Athens, Georgia
Peoria, Illinois
Beltsville, Maryland
Ithaca, New York
Raleigh, North Carolina
Lubbock, Texas

Examples of Recent Progress:

Ammonia accumulation in leaf material not caused by photorespiration - Albany, California. The finding that ammonia accumulation is responsible for chemically induced toxicity in leaf material and that this accumulation is not attributable to photorespiration is contrary to widely held opinions about the photorespiration process. These findings should shed new light on the interaction of the carbon and nitrogen cycles in photosynthesizing plants.

Molecular structure and energy in zinc porphyrins elucidated - Albany, California. The relative importance of molecular structure and energy in zinc porphyrins has been clarified. The identification of zinc porphyrin as an analogue of chlorophyll should enable us to more clearly understand the light-to-energy conversion in plants.

Divalent Cation Effects on Photosystem II Reactions - Peoria, Illinois. Based on the flash yield for O_2 evolution, the activity of Photosystem II reaction centers is not affected by cation-depletion. The effect of divalent actions on O_2 evolution was measured by using both concentration and rate electrodes. Earlier, scientists observed an inhibition in O_2 flash yield by cation depletion, and this inhibition was relieved by addition of $MgCl_2$. They concluded that Mg^{2+} induced an activation of

PSII reaction centers. NRRC researchers have now found that the apparent inhibition in O_2 flash yield is actually due to slow settling of cation-depleted thylakoids on the electrode surface, which results in lower O_2 flash yield. Addition of $MgCl_2$ enhances O_2 flash yield by greatly increasing thylakoid settling rates but not by activating PSII reaction centers.

Double Turnovers in Photoreactions - Peoria, Illinois. Characteristics of Photosystem II charge separation and oxygen evolution processes in algae and chloroplasts indicate two types of double hitting or advancement in S-states (forms of energy states by the systems in oxygen evolution), a nonphotochemical type found with flashes as brief as 5 nanoseconds, and a photochemical type only seen with microsecond-long flashes. The nonphotochemical type is sensitive to physiological condition and is only present in freshly prepared samples. Furthermore, kinetics of the processes involved in double advancement in S-states for oxygen evolution are quite distinct from those involved in double turnovers in charge separation. The former is in a range of microseconds, whereas the latter is in a range of tens of nanoseconds. Concepts of the oxygen-yield mechanism are, in addition, simplified by experiments with ferricyanide-treated chloroplasts, which show that one proposed solution to the oxygen S-state distribution is invalid.

HPLC System Developed - Peoria, Illinois. A study of the greening process with etiolated red kidney beans led to the development of a HPLC system for the determination of protochlorophyllide, chlorophyllide, and intermediates in the production of chlorophyll a. New forms of chlorophyll a, which are important in the early stages of greening, were discovered and partially characterized.

Potential reduction in photorespiration - Urbana, Illinois. An objective of this project is to reduce or eliminate photorespiration. Past work has indicated that this could be accomplished by modifying ribulose-1,5-bisphosphate carboxylase so that the enzyme reacts more readily with CO_2 and less readily with O_2 . It has been suggested by other researchers that this approach is not likely to be successful because, it is presumed, oxygenation is an inevitable consequence of the carboxylase reaction mechanism. From the analysis of this enzyme from several diverse species, we have shown that considerable variation in the enzyme exists, and that evolutionary pressures have altered the enzyme to increase its specificity toward CO_2 . This observation provides some optimism that the application of appropriate selection pressure may lead to reduced photorespiration.

Site of chilling injury identified - Urbana, Illinois. The intolerance of thermophilic crops to chilling night temperatures has a profound effect on the practices of agriculture. Chilling injury causes extensive losses, and because it delays growth in the spring, chilling is an important cause of unattained production potential. Because warm weather crops are excluded from cool regions, the farmer must often substitute a lower yielding, early maturity cultivar or an entirely different, less desirable crop. Even in warm regions, early planting which would avoid exposure of the crop to late

summer drought cannot be practiced because of the possibility of cool nights. An understanding of the fundamental basis for the difference between chilling tolerance and chilling intolerance is an essential step toward the ultimate goal of reducing the constraints which chill sensitivity places on agriculture. We have shown that there are two distinct elements to the inhibition of photosynthesis by chilling. A portion of the impairment is attributable to decreased stomatal conductance, but the more significant part is due to disturbed chloroplast function. We have identified essential chloroplast activities which are depressed by chilling and others which are not.

Technological Objective 2: Improve nitrogen fixation efficiency of bacteria-plant associations and develop nitrogen-fixing capabilities in crops lacking this capability in order to reduce energy requirements for crop production.

Research Locations:

Albany, California
Gainesville, Florida
Peoria, Illinois
Beltsville, Maryland
St. Paul, Minnesota
Raleigh, North Carolina

Examples of Recent Progress:

Fungus enhances soybean growth in phosphorus-deficient soils - Albany, California. The capability of legumes and *Rhizobium* bacteria to fix nitrogen in poor soils is further enhanced by another symbiont, a fungus which infects the plant root and enhances its capability to obtain phosphorus and, possibly other nutrients from mineral-deficient soil. We have performed experiments to determine quantitatively the extent of fungal infection and growth enhancement of soybeans infected with the fungus in phosphorus-deficient soil.

Identification of *Rhizobium japonicum* strains with genetic exchange ability - Beltsville, Maryland. Screening diverse strains of a nitrogen-fixing symbiont of soybean for gene transfer has resulted in the identification of six strains as genetic exchangers (GE). GE strains may prove to be the source of genetic materials that will permit the mapping and identification of genes controlling symbiotic nitrogen fixation.

Rhizobium mutants that specifically lack proteins required for nitrogen-fixation - Beltsville, Maryland. Mutants that form apparently normal nodules on soybeans but which do not fix nitrogen have been found to lack specific proteins involved in symbiotic nitrogen fixation. Thus, mutant methodology as applied to determine the biochemical prerequisites leads to the improvement of biological nitrogen fixation.

Tryptophan biosynthesis defined in *Rhizobium japonicum* - Beltsville, Maryland. The precise characterization of tryptophan auxotrophs with enzyme activity measurements has defined the specific metabolic block characteristic of ten mutant strains of *Rhizobium japonicum*. These mutations will be of use as genetic markers for mapping and identifying genes controlling symbioses.

The relation of physiological traits for nitrogen metabolism to soybean yield - Raleigh, North Carolina. High N_2 fixation capability before pod development, coupled with remobilization of vegetative tissue N during pod development, and high N_2 fixation capability during pod growth were shown to be physiological traits associated with the yielding ability of soybean cultivars. This was determined by growing nodulated plants of two determinate cultivars in a culture system free of soil or fertilizer nitrogen and by measuring accumulation of nitrogen in the plants from early pod development to maturity. If high N_2 fixation capabilities before pod development and during pod growth can be combined with the use of plant breeding methods, it may be possible to develop a soybean cultivar with higher N_2 -fixing and yielding ability than cultivars presently in production.

Discovery of a new N_2 -Fixing System - Raleigh, North Carolina. A hitherto unknown N_2 -fixing system that does not have an apparent requirement for molybdenum in the free-living N_2 -fixing bacterium *Azotobacter vinelandii* was discovered. The implications of this finding are far-reaching as they relate to the reduction of N_2 by N_2 -fixing microorganisms. It is possible that this alternative N_2 -fixing system may be ideally suited for introduction into crops which do not presently fix N_2 .

Identification of ineffective and non-nodulation genotypes of alfalfa - St. Paul - Minnesota. Five plant-mediated ineffective genotypes and one non-nodulation genotype were identified. This is the first report of either ineffective nodulation or non-nodulation in alfalfa. Inheritance studies indicated that four of the five ineffective nodulators were controlled by different genetic systems. Observations by electron microscopy indicated that the ineffective genotypes had two distinct morphological patterns. One type was gall-like with multiple meri-stems and the other type resembled normal nodule growth in the early stages, but the bacteroids senesced rapidly.

The discovery and description of the ineffective and non-nodulation traits are important because they provide N_2 -fixation researchers with a unique set of tools that may be used to: a) investigate different steps in the process of nodulation, b) provide an inexpensive method for estimating the proportion of nitrogen in plant tissue derived from N_2 -fixation, and c) develop a genetic system where plants could control *Rhizobium* strain selection.

Technological Objective 3: Develop new and improved cell and tissue culture technology for plant improvement through increased genetic diversity and rapid vegetative propagation.

Research Locations:

Albany, California
Peoria, Illinois
Beltsville, Maryland
Madison, Wisconsin

Examples of Recent Progress:

Freezing injury reduced by chemical cryoprotective agents in tissue cultures - Albany, California. Living plant cells grown as tissue cultures may be protected from freezing by use of chemical cryoprotective agents. We have demonstrated that with several species, plantlets may be produced from such frozen and thawed tissue. This will allow frozen storage of desirable genetic material of plants that do not reproduce well from seed.

Development of molecular probes for plant viroids - Beltsville, Maryland. Recombinant DNA techniques have been used to develop a probe for potato spindle tuber (PSTV) RNA. DNA complementary to PSTV was synthesized in vitro, inserted into a bacterial plasmid, and cloned in the bacterium Escherichia coli. Large amounts of the homogeneous recombinant DNA molecules have been isolated and are being used as molecular probes to learn how viroids multiply in host plant cells. The cloned PSTV probe will now permit for the first time the development and precise tests for the large-scale detection of PSTV in potato seed and breeding stock.

Molecular cloning of the tumor inducing (Ti) plasmid of Agrobacterium tumefaciens - Beltsville, Maryland. Large fragments of the Ti plasmid of Agrobacterium tumefaciens have been cloned in Escherichia coli by using a recombinant DNA technology. The fragments include the regions involved in the integration and tumorigenic process of the crown gall disease. These clones will provide purified DNA fragment for the development of a gene transfer vehicle for protoplast transformation experiments.

In vitro propagation system has been developed for plum rootstock - Beltsville, Maryland. An in vitro propagation system has been developed for plum rootstock 'Myrobalan' (the most widely used plum rootstock). Rapid massive production of vigorous 'Myrobalan' selections is now possible.

Technological Objective 4: Develop technology for improving the absorption, translocation, and utilization of nutrients and water to increase crop production efficiency.

Research Locations:

Beltsville, Maryland
Corvallis, Oregon
Lubbock, Texas

Examples of Recent Progress:

Characterization of iron reduction mechanisms clarify iron availability in Fe-efficient and Fe-inefficient plants - Beltsville, Maryland.

Chemical reduction. Caffeic acid was identified as a principal Fe^{3+} -reductant produced by tomato roots determining iron uptake and plant availability. Ferrous iron is the form absorbed by plants. Fe-efficient roots produced more reductant than Fe-inefficient roots. In contrast, Fe-inefficient roots showed higher diphenol oxidase activity which destroys caffeic acid. Precursor compounds (p-coumaric acid and phenylalanine) added to plant nutrient solution led to the enzymatic formation of caffeic acid and derivatives. Concurrent with caffeic acid production, regreening and growth resumption of iron-stressed (chlorotic) plants occurred.

Photochemical reduction. Ultraviolet and blue light reduced ferric iron to the ferrous form. Ferrous iron is more effectively utilized in metabolism than the ferric form. Iron is transported to plant tops primarily as ferric citrate. The ferric iron is readily photoreduced when chelated with citric acid. ^{59}Fe and ^{14}C labeled experiments characterized the light-mediated reduction of Fe^{3+} . Photoreduction was accompanied by decarboxylation of C-1 carboxyl groups of citric acid degrading the organic acid moiety. Free ferrous iron was liberated in the process.

Technological Objective 5: Improve technology for better crop production under environmental stress.

Research Locations:

Albany, California
Beltsville, Maryland
Lubbock, Texas

Spectroscopic study on configuration and packing of n-alkanes - Albany, California. An extensive spectroscopic study on the configuration and packing of n-alkanes provided a basis for interpreting such measurements on lipids and, in turn, will lead to an understanding of the molecular basis for plant response to stress. This understanding will allow us to define methods for protecting plants from temperature, salt, or acidity extremes.

Technical Objective 6: Develop new technology for control and regulation of biochemical, physical, and morphological processes of plants.

Research Locations:

Pasadena, California
Athens, Georgia
Beltsville, Maryland
Mississippi State, Mississippi
Ithaca, New York

Examples of Recent Progress:

Hormone effects on sucrose uptake - Beltsville, Maryland. Two plant hormones have opposing effects on sucrose uptake against its gradient in isolated root sink tissues of sugarbeet. Sucrose uptake is inhibited by IAA, whereas, ABA usually stimulates it. This and other aspects of hormonal physiology/ biochemistry in sugarbeets should lay the foundation for more sophisticated studies on the use of plant growth regulators for controlling sugarbeet growth and development and thereby increasing crop productivity.

Brassinosteroids promote plant growth - Beltsville, Maryland. Two analogs of brassinolide, the plant growth promoter isolated from rape pollen, have been prepared and evaluated in greenhouse and field studies. These biologically active brassinosteroids (BR) are tetrahydroxy-steroid lactones with a C-24 methyl group. The synthetic analog $2\alpha, 3\alpha, 22(\beta), 23(\beta)$ -tetrahydroxy-24(β)-methyl- β -homo-7-oxa-5 α -cholestan-6-one was evaluated in field studies for the second year. During the 1980 season, crop yields were 25 percent less on unfertilized plots compared with fertilized plots but this loss in yield was recovered when plants were repeatedly treated (at least 3 times) with 0.01 ppm of BR. BR treatment caused yield increases of lettuce, radishes, and red beet from 8 percent to 54 percent depending upon the crop and field nutrition status. The eyes of Cobbler potato seedpieces were treated with BR and greened for 4 days before being planted in a fertilized field. BR treatment caused an increase over the controls of 21 percent in number and 21 percent in weight of marketable potatoes.

Adaptation to dry conditions affects plant growth rates - Beltsville, Maryland. In many cases, individual plants with faster than average growth rates when moisture is not limiting, grow slower than average plants when water shortage reduces growth. Thus, selection that improved the efficiency of solar energy conversion in one environment was found to decrease the efficiency in another environment.

Unusual response of Calvin cycle and starch synthesis enzymes to photosynthetic duration in relation to dry matter production - Beltsville, Maryland. Spinach and soybean plants were grown on a long photosynthetic period (12-14 hours) and compared to those grown on a shorter photosynthesis period (7 hours). The plants on the long period had lower rates of leaf photosynthesis and starch synthesis and decreased activity of several of the enzymes of the pentose phosphate reductive cycle and the starch synthesis enzyme, ADP-glucose phosphorylase, in the chloroplasts as compared with those on the shorter period. However, even with the lower rates of leaf photosynthesis and starch synthesis, the plants on the longer photosynthetic period accumulated more dry matter per unit of leaf area than the plants on the shorter period.

The correct interpretation of these plant responses is highly significant. Shorter photosynthetic periods induce higher photosynthetic rates. In terms of dry matter accumulation by the plant, however, a sufficiently longer photosynthetic period at a lower rate can equal or exceed the dry matter gained via higher photosynthetic rate during the shorter photosynthetic period.

Thirty-three of 75 Mississippi plants possessed allelopathic activity - Mississippi State, Mississippi. Melilatic acid, isolated from white sweet clover flowers, was allelopathic at 10 ppm. Three new allelopathic flavonoids were identified from the roots of *Sciatellaria ovata*. These findings confirm that several important Mississippi plants possess highly active allelopathic agents that can restrict the germination and growth of crop plants. These findings also indicate that there may be disadvantages of some consequence to the use of clovers as a cover crop.

Certain primitive stocks of *Gossypium hirsutum* cotton possess 20% of dry weight as tannins - Mississippi State, Mississippi. These plants are resistant to spider mites, bollworms, leaf miners, and cotton leaf perforators. Tannin has also been shown to be toxic to insects in laboratory feeding bioassay. Crosses have been made of these resistant plants with agronomic cultivars. There is evidence that the high tannin characteristic can be transferred to agronomic lines.

Quality-Control Test to Determine Clonal Identity of Plantlets - Pasadena, California. Genetically deviate tissue-culture-derived plantlets are not detectable until the adult vegetative and fruiting stages. Electrophoretic techniques with gene-enzyme systems allows plantlets to be examined genotypically at the leaf initiation stage to determine the occurrence of mutations. This technique would enable unwanted aberrant plantlets to be detected and eliminated. This quality-control test will allow plantlets to be produced from long-lived fruit trees with tissue culture with a greater degree of confidence of their clonal nature than without such a test.

Cryostorage of Crop Germplasm - Pasadena, California. Crop germplasm repositories are expensive to maintain and are susceptible to pests, diseases, and genetic alterations. Embryogenic date palm callus cultures have been stored up to 3 months at the temperature of liquid nitrogen (-196°C), then thawed and have regenerated viable plantlets. Cryogenics, coupled with micropropagation, offers an alternative method to preserve germplasm free of the drawbacks common to field collections. Development of cryostorage methods for other crop germplasm could provide backup insurance germplasm reservoirs which may save millions of dollars which are currently used in maintaining field collections.

New plant growth inhibitors of unique chemical structure - Tifton, Georgia. Dihydropergillin is a new fungal natural product obtained from the fungus *Apergillus ustus* that has moderate plant growth inhibitory properties. It inhibits wheat coleoptiles at 10^{-3} and 10^{-4} M. The molecule is related to pergillin (briefly reported last year) but differs by the addition of two hydrogen atoms, one at C12 and the other at C13. These two atoms change the stereochemistry of the molecule and dihydropergillin is ten times more active than pergillin. Dihydropergillin, a unique structure, may be a useful template on which to synthesize other active chemicals because minor structural changes produce large changes in biological activity.

In cooperative work, two new biologically active metabolites were isolated, identified, and bioassayed. They are Wentilactone A, which inhibited wheat coleoptiles 48% at 10^{-5} M and Wentilactone B, which inhibited wheat coleoptiles 81% at 10^{-4} M (but was inactive at 10^{-5} M). The differences in response offer an interesting insight into slight structural differences versus biological activity.

Technological Objective 7: Develop technology for reducing damage to crop plants from air pollutants.

Research Locations:

Beltsville, Maryland

Mixtures of sulfur dioxide and ozone reduce tomato yields - Beltsville, Maryland. Field studies in 1980 at Beltsville, Maryland, reveal that ambient oxidants reduce by 17% the fruit yield of Jet Star, a widely grown tomato cultivar. The highest dose of sulfur dioxide (0.48 ppm, 5 hr/day, for 57 days from July 2 to September 29) reduced the yield about 18%. When the two pollutants were combined, the yield loss was 32%. Fruit quality was not altered as judged by various tests. A high correlation ($r = -.98$) was found between increasing SO_2 concentration and tomato yields. This dose-response information obtained under field conditions is of benefit to the United States Department of Agriculture, which is concerned with crop productivity, and to the Environmental Protection Agency having responsibility for development of air quality standards to protect health and welfare.

Oxidant stress protection research aids the evaluation of air - Beltsville, Maryland. Investigations with growth regulating chemicals and environmental conditioning to manipulate the physiology of oxidant-sensitive plant cultivars show that factors which retard senescence enhance plant tolerance to chronic oxidant stress. Control of the photosynthate sinks and chemical supplies along with proper iron nutrition (therefore, Fe-enzymes and redox agents that function in energy metabolism) were shown to be highly important in the development of oxidant tolerance. Iron-inefficient plants were more oxidant-sensitive than Fe-efficient ones. Oxyradical scavenging redox enzymes in leaves appear to team up with effective energy transfer processes to slow aging and mitigate oxidant stress.

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National Research Program 20180

CROP POLLINATION AND HONEY PRODUCTION

National Research Program 20180 involves research designed to develop new knowledge that may improve current technology in: managing honey bee colonies, apiaries, and wild bees; protecting honey bees and wild bees from pesticides, diseases, and pests; increasing the effectiveness of honey bees and wild bees as pollinators; and breeding honey bees. Two major problems face the beekeeping industry. The first is the hazardous relationship between bees and pesticides. The other is the potential entry into the United States of the Africanized bee in one case and two exotic pests, the Acarine mite and the Varroa mite, in the other.

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Technological Objective 1: Improve management of honey bees to provide most effective crop pollination and honey production.

Research Locations:

Tucson, Arizona
Beltsville, Maryland
Stillwater, Oklahoma
Madison, Wisconsin

Examples of Recent Progress:

Types of Sugars Present in the Nectar of Twelve Gynoecious Pickling Cucumbers - Tucson, Arizona. This work is a part of the long range study of honey bee preferences for gynoecious cucumbers. Fructose, glucose, and sucrose have been found in the nectar of all 12 gynoecious pickling cucumbers. The percentage of sugar varies between male and female flowers of individual cultivars.

Total Dissolved Solids Based on Refractometry Possibly Inaccurate - Tucson, Arizona. Pollination ecologists should not rely solely on hand refractometers. Floral nectars often contain dissolved components other than sugar that contribute to the readings given by the refractometer. At least one other definitive technique should be used to document the kinds and amounts of sugars present in any floral nectar.

Documentation of UV-Absorbing and Fluorescing Compounds in Nectar - Tucson, Arizona. High Performance Liquid Chromatography (HPLC) shows the presence of UV-absorbing and fluorescing constituents in nectar. HPLC methodology offers an easy way to separate these constituents for chemical identification and subsequent bioassay as modifiers of honey bee behavior.

Microbes Associated with Honey Bees Preserved by Freeze-Drying - Tucson, Arizona. All yeast, bacterial, and mold cultures isolated from honey bees and their food are being lyophilized as time permits. These cultures can be used in future work on microbial contributions to honey bee nutrition.

Terramycin not a Residue Problem if Used Properly - Tucson, Arizona. Terramycin was not detected in honey above the brood area (surplus honey) 4 weeks after medication with terramycin in sugar syrup, sugar dusts, and extender patties. Beekeepers should wait at least 4 weeks after last spray or dust treatment to extract surplus honey.

Role of Pollen Lipids in the Honey Bee Diet - Tucson, Arizona. When all unbound lipids are extracted from pollen, young bees cannot distinguish between normal pollen (lipid rich) and extracted pollen (lipid poor). Both normal and lipid-extracted pollen support equally good growth and survival of honey bees. Normal pollen and lipid poor pollen fed to mini-colonies show little difference in resultant colony growth (egg, larval, pupal production, and survival).

Amino Acids in the Floral Nectar of Cotton - Tucson, Arizona. Four amino acids (aspartic acid, serine, threonine, and glutamic acid) have been found in the nectar of two cotton cultivars. Nectar from another cultivar contains 14 amino acids. Amino acids in nectar from plants sprayed with various levels of 2,4-D fluctuate with time and treatment. Treatment with 2,4-D increases the volume of floral nectar and thus the quantity of nectar amino acids per flower.

Pollen-Sugar Diets Consumed More Readily than Yeast-Based Protein Diets - Tucson, Arizona. Honey bees in free-flying colonies consume 123 mg of pollen-sugar diet per pupa as compared to 77 mg of yeast diet per pupa. The lack of consumption is attributed to a lack of the specific phagostimulants found in pollen. Comparisons of the nutrient contents of the yeast diets suggest low and unbalanced amounts of major nutrients needed to support brood rearing. These studies are part of a long-term goal to develop better understanding of honey bee nutrition.

Adult Populations and Available Diet Influence Brood Rearing - Beltsville, Maryland. The colony size (adult population) and amount of diet available are factors limiting a colony's development. The adult population is the most important factor determining the rate of brood rearing.

Pollen Substitute Developed and Tested - Beltsville, Maryland. Studies indicate that the lactalbumin-yeast pollen substitute (Beltsville Bee Diet), unfortified with cholesterol and salt, was adequate for normal colony development. The brood-rearing ability of honey bee colonies fed the Diet exceeded brood rearing of honey bee colonies fed one-year-old pollen by 100 percent and approached (89 percent) brood rearing of honey bee colonies fed fresh pollen. The Beltsville Bee Diet has been formulated by a private company for field testing at various locations. If tests are favorable, the Diet can be available for the general market in 1982.

Temperature Range Important in Shipping Queen Honey Bees and Package Bees - Beltsville, Maryland. The problem of queens and bees dying in transit has been investigated with the cooperation of the Office of Transportation. Queens in transit should be maintained within a temperature range of 60-105° F. Package bees should be maintained within a temperature range of 50-100° F. Most bees that die in transit do so from lack of adequate ventilation and subsequent temperature buildup, not from CO₂ buildup.

Insulation for Overwintering Colonies - Madison, Wisconsin. Insulated hive covers were formed from natural translucent or opaque yellow corrugated sheet plastic and were placed over colonies; they were compared with unprotected colonies to determine the value of the sheet plastic covers on outdoor wintering of honey bee colonies. Translucent covers were more effective than yellow covers, but the difference was not significant. Significantly less stores were consumed by all covered colonies than by unprotected colonies.

Two Inexpensive Soybean Products Available as Substitutes for Expeller-Processed Soyflour - Madison, Wisconsin. Two soy protein replacements for expeller-processed soyflour were identified. Both proved to be satisfactory when fed to honey bees either with pollen as a pollen supplement or alone as a pollen substitute. When these products were fed to bees for up to 4 weeks in the absence of pollen, levels of brood rearing were greater than or comparable to those obtained from bees fed pollen and populations were more uniform.

Heat Exchanger to Regulate Soil Temperature of Individually Potted Plants - Madison, Wisconsin. A water jacket for a single pot has been developed to allow unrestricted drainage of potted plants. Heat exchange occurs between the soil and the temperature-controlled water that circulates through the water jacket, thus allowing soil temperature to be maintained within 0.5° C. The unit is inexpensive to manufacture and operate, and it is easily manipulated under experimental conditions to study the effects of edaphic factors on nectar secretion. A public patent is sought.

Technological Objective 2: Improve methods of protecting bees from pesticides, diseases, pests, and pollution.

Research Locations:

Tucson, Arizona
Beltsville Maryland
Laramie, Wyoming

Examples of Recent Progress:

Perception of and Adaptation to Ultrasound by the Greater Wax Moth - Tucson, Arizona. A statistically significant number of wax moths can be prevented from infesting honey bee colonies with electronic devices that mimic the cries of predacious bats. Ultrasounds of 100 kHz are more effective than 40 kHz and prevent 50 to 84 percent of the moths from reaching the beehive.

Computer Simulation of Pesticide Kills and Reduced Adult Bee Longevity - Beltsville, Maryland. In computer simulations colonies that suffer a 100 percent loss of foraging bees for one week show a 30 percent reduction in honey yields. Colonies sustaining a 25 percent loss of foraging bees for one week show no noticeable effect. The computer simulated colony shows a 40 percent reduction in honey production when the longevity of adult bees is reduced by 50 percent during the April 15-June 1 period.

Stresses Associated with Moving Colonies not an Influence on Incidence of European Foulbrood Disease - Beltsville, Maryland. European Foulbrood disease (EFB) is often detected in honey bee colonies moved for fruit and berry pollination. However, colonies moved four times to determine if this stress factor increases the severity of the disease have shown no increase in incidence of EFB over that of control colonies not moved.

Disease Organisms from Bees Dying During Winter - Beltsville, Maryland. The most prevalent organisms identified in dead bees collected daily from traps January 1 to March 16 have been F-virus, Nosema apis, and Crithidia mellificae. Of the three, only the F-virus infection level is in direct proportion to the mortality rate.

Non-Chemical Control of Greater Wax Moth for Stored Unused Combs - Beltsville, Maryland. Drawn combs sprayed on both sides with Certan® Bacillus thuringiensis and stored for 6 months remain free of wax moth damage even when wax moth eggs are placed on the combs. When treated combs (used in hives with bees for 6 months) are placed in an incubator, they are quickly damaged by wax moth larvae. Even combs in honey supers lack protection from B. thuringiensis. The results suggest that bees remove the B. thuringiensis when cleaning combs, thus leaving the combs unprotected.

Varroa jacobsoni Not Found in Maryland Survey - Beltsville, Maryland. Maryland Department of Agriculture, University of Maryland, and the Bioenvironmental Bee Laboratory, SEA-AR, have cooperated in the examination of 412 lbs of adult bees and brood from 74 colonies in a 5-mile radius and a followup examination of frass from the bottom boards of all colonies. Varroa jacobsoni mites were not found, thus refuting the reported finding last year.

Flight Activity of Honey Bee Colonies Gorged with Sugar Syrup - Laramie, Wyoming. When the combs of both hive bodies of a 2-story colony were sprayed with sugar syrup, flight activity was reduced by 50 percent. The technique may be used to keep foraging bees in the hive when crops are sprayed with insecticides.

Honey Bees Collected in Mexico Infested with Acarine Mites - Laramie, Wyoming. The identification of Acarapis woodi in bees from Mexico is the first report of the parasite on the North American continent.

Residues of Methomyl Remain in Combs for Over a Year - Laramie, Wyoming. Lannate residues have been detected in combs stored for one year after honey bees visited fields sprayed with the insecticide. When contaminated combs were used for package bees, large numbers of bees died.

Technological Objective 3: Determine pollination requirements of economically important crops.

Research Locations:

Tucson, Arizona

Examples of Recent Progress:

Pollination of Onions Increased with Stronger Honey Bee Colonies - Tucson, Arizona. Honey bees foraging on onions were tagged, and the tags were recovered at hive entrances. Recoveries from 1-, 2-, and 3-story colonies have indicated that the foraging activity is increased in 50-percent increments for each hive story.

Hybrid Cottonseed Production Fields Pollinated by Honey Bees - Tucson, Arizona. Honey bees have been moved to the Texas High Plains to pollinate hybrid cotton produced from male-sterile plants. Bee visitation to the male steriles exceeds acceptable levels. Boll set on male-sterile rows equals that on the male-fertile rows. These preliminary studies demonstrate that hybrid cottonseed production with honey bee pollination is technologically feasible.

Technological Objective 4: Identify and study biology of wild bee pollinators and improve methods of using wild bees for crop pollination.

Research Locations:

Logan, Utah

Examples of Recent Progress:

Non-Apis Pollination of Apple and Pear Orchard - Logan, Utah. A population of only 250 female *Osmia lignaria* has been used to pollinate a 6.5-acre apple-pear orchard. Fruit production of pears and Red Delicious apples has been excellent. A 4.3-fold increase in the bee population has been realized. Placement of nest materials on trees throughout the orchard has drastically reduced drifting of released bees.

Non-Apis Pollination of Onion - Logan, Utah. Onion seed production from single-bee visits indicates that native bees set more viable seeds per visit than do honey bees. Single honey-bee visits to male-sterile onion flowers result in a high percentage of aborted seed.

Hybridization Study with Eastern and Western Forms of *Osmia lignaria* - Logan, Utah. Attempts to hybridize these two forms under greenhouse conditions have resulted in male progeny only. Data suggest that the two allopathic forms are isolated genetically and each should be considered distinct species.

Technological Objective 5: Improve honey bee breeding and rearing knowledge of bee genetics and germplasm maintenance.

Research Locations:

Baton Rouge, Louisiana

Examples of Recent Progress:

A Pheromonal Basis of Aggressive Behavior in Honey Bees Determined - Baton Rouge, Louisiana. Of 20 compounds identified from honey bee sting extracts, 15 function as alarm pheromones.

Response of Honey Bees to Alarm Pheromone - Baton Rouge, Louisiana. Preliminary tests indicate that a mixture of the 10 most abundant sting alarm pheromones produces a response similar to isopentyl acetate (one of the 10) alone.

Developmental Times of Female Honey Bee Eggs Significantly Shorter Than That of Male Eggs - Baton Rouge, Louisiana. Haploid and diploid male eggs require about 3 hr longer to develop than do diploid female eggs. Female eggs kept at 34.8° C. hatch about 1.4 hr sooner than female eggs kept at 34.3° C.

Technique Used to Inseminate Queens can Change Sperm Transfer into Spermatheca - Baton Rouge, Louisiana. Two inseminations of 1.1μ of stored semen (diluted with equal parts of saline) result in 0.82×10^6 sperm stored in the spermatheca. One insemination results in only 0.26×10^6 sperm stored. The second insemination more efficiently transfers sperm. Similar results have been obtained with fresh sperm.

Caged Honey Bees Show a Preference for High-Fructose Corn Sweetener - Baton Rouge, Louisiana. Laboratory tests show that honey bees prefer liquid high-fructose corn sweetener to sucrose syrup and remove more of it from feeders.

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National Research Program 20190

IMPROVED METHODS AND EQUIPMENT FOR PRODUCTION OF FIELD, HORTICULTURAL, AND FIBER CROPS

The cost of production and the field losses resulting from present methods of harvesting continue to be a concern of both growers and consumers. The purpose of this program is to develop new or improve existing harvesting equipment which can reduce production costs and field losses while maintaining acceptable quality of the resulting commodities. The improved equipment may reduce field losses, improve the product quality, or reduce labor and machinery costs, depending on the particular crop involved and the technological opportunities available.

Technological Objective 1: Develop improved equipment for harvesting crops to reduce field losses, improve quality, and reduce labor and machinery costs.

NPS Contact: L. A. Liljedahl

Research Locations:

Albany, California
Salinas, California
Belle Glade, Florida
Lake Alfred, Florida
Tifton, Georgia
Urbana, Illinois
East Lansing, Michigan
Stoneville, Mississippi
Lubbock, Texas
Suffolk, Virginia
Wenatchee, Washington
Kearneysville, West Virginia

Examples of Recent Progress:

X-Ray scanning and evaluation system for lettuce heads developed - Albany, California. An X-ray probe has been developed and interfaced with a micro-processor system which is capable of detecting and measuring lettuce plants standing in the field. These measurements can in turn be directly related to the commercially important parameters. Thus it is now possible to "weigh" and "size" a load of lettuce still standing in the field without cutting or trimming it. The entire system is tractor-mounted and finds application in breeding (selecting heads for uniformity), forecasting (predicting when a field will be ready for harvest), and harvesting (selecting heads to be harvested currently).

Dry red chili pepper harvester developed - Salinas, California. Plastic belts with 3-inch-long fingers were tested for removing peppers from the plant in place of aluminum fingers tested previously. The plastic belts are not damaged by rocks, operate more quietly, and are probably safer than the aluminum fingers. The direction of belt travel on the vibrating cleaner was changed to improve its operation, and a mesh belt was added to clean peppers recovered with the picking head. Rotating brushes were added to the pick-up head to tighten the windrow of peppers before they are picked up out of the furrow. This made the operation of the pick-up less sensitive to the shape of the furrow. Under good field conditions the harvester consistently recovered 90% of the peppers with the pick-up operating and 75% of the peppers without the pick-up operation.

Semi-automatic film wrapper for lettuce improved - Salinas, California. The wrapping machine previously developed now reliably seals lettuce heads into a plastic pouch at the rate of 40 per minute in laboratory operation. A photo cell circuit was developed to detect the heads and actuate the sealer bars at the appropriate time. The sealer is insensitive to the size and shape of the heads. The heads are placed by hand in a trough formed by the plastic film and the film carries the heads through the machine until they are sealed when they fall onto a conveyor.

Forage harvester principles may be used for harvesting sugarcane for biomass - Belle Glade, Florida. A forage harvester was used to cut cane and sweet sorghum. Cane and sweet sorghum with low tonnage per acre harvested easier than cane with high tonnage per acre, an indication that modifications to the gathering mechanism of the forage harvester will be necessary. A forage harvester was also used to recover cellulose residue left in the field after sugarcane harvesting. This recovered about 1.5 tons per acre dry matter residue left in a cane field after conventional sugarcane harvesting. The residue was found to field dry to about 35 percent moisture but the bulk density was lower than expected.

Mechanical harvesting system developed for 'Valencia' oranges - Lake Alfred, Florida. Harvesting technology using a combination of tree shaking equipment and an abscission chemical that has worked successfully in early and mid-season oranges was shown to be effective in harvesting late season (dual-crop) 'Valencia' oranges when harvesting was done early in the 'Valencia' season before the natural young fruit drop diminished. The Valencia orange variety accounts for approximately 45% of the Florida orange production.

New principle discovered for measuring peanut pod maturity - Tifton, Georgia. A new method of peanut pod maturity classification promises to be a useful technique for determining the time of digging for maximum yield and market quality. Classification by this method requires scraping or mechanically removing the pod exocarp to expose vivid, maturity-related differences in mesocarp color and structure. Through these color and structured relationships of pod numbers at various maturity stages, a profile can be established which represents the overall risks of pod loss relative to pod gain. Such an evaluation can be an excellent tool for increasing harvestable yield.

Impact cutting proved feasible for soybean harvesting - Urbana, Illinois. Soybean harvest losses, although lowered by recently introduced commercial soybean headers, still are about 4 percent of the gross yield. In test stand comparisons of several flexible impact cutting systems, plant stem accelerations and harvest loss levels were not significantly different under some test conditions from those resulting from the built-in flexible cutterbar configuration. Improved design and refined operating procedures could provide a high-speed cutting system with reduced harvest loss potential.

Commercial cucumber harvesters unsatisfactory for "little pickles" - East Lansing, Michigan. The 1980 field tests with modifications of a conventional harvester showed that all attempts to recover a high percentage of 10- to 27-mm-diameter pickles failed. Recovery averaged only 32%, and damage was excessive. A threshing concept was added to the harvester, ahead of the conventional pinch rolls, and a doubling of recovery resulted.

Recovery improved on rhubarb harvester - East Lansing, Michigan. The first year's mechanical harvest data were taken by testing the standard spacing of 122 cm and nonstandard spacings of 61, 46, 30, and 15 cm. Recovery of 'Valentine' increased from previous year's 58% to 70%. Average mechanical harvest recoveries were: 'Valentine' 70.1%, 'Chipman' 67.4%, 'McDonald' 46.5%. The McDonald's low recovery resulted from a severe windstorm 4 days before harvest. In general, recovery was unaffected by plant spacing. Pick-up design improvements were installed on another commercial harvester and tested by a grower in June 1980. The belt did not jump off in larger-stalked varieties as before.

Preharvest cotton quality losses from weather predicted with new model - Mississippi State, Mississippi. An equation was developed to predict cotton preharvest losses as a function of boll age, daily rainfall, and wind movement. Regression techniques were used along with 1978 data to determine the parameter values in the equation from observed data. Data for 1979 were used to validate the model. The model performs reasonably well when significant weather events occur. The relationship indicates that the pre-harvest quantity losses are exponentially related to the age of the cotton boll and to discrete weather events which include rain in excess of 1.3 cm and wind in excess of 80 kilometer-days.

Best means of reducing fine material in bur cotton determined - Lubbock, Texas. The effect of variety, harvest date, and harvest method on fine material in bur cotton was evaluated. Harvest method had the most significant effect on fine material. The operation of stripper rolls in the low harvest method increased fine material in bur cotton from 91 to 128 kg/ha. Sixty-five to seventy-five percent of the fine material was soil particles. Raising the stripper rolls decreased fine material but increased harvest loss from 6% to 10%. Plant lifters on cotton strippers need to be modified to decrease fine material and to minimize harvester losses.

Optimum stripper roll adjustments identified - Lubbock, Texas. The spacing between stripping rolls was found to affect harvest loss and quantity of sticks harvested from plants of different size and moisture content. Harvest loss was greatest for tallest plants, at the highest moisture content, stripped with the widest spacing between stripping rolls. The quantity of harvested sticks was greatest from tallest plants, at the lowest moisture

content, stripped with the narrowest spacing between stripping rolls. A 1.1-cm spacing between rolls produced the optimum combination of harvest loss and quantity of harvested sticks.

Development of prototype direct peanut harvester - Suffolk, Virginia.

Peanuts harvested with the direct peanut harvester are damaged less during harvesting than conventionally harvested peanuts, and are not subjected to adverse weather in the windrow. Additional drying cost is required for peanuts harvested by the direct peanut harvester; however, dryers can be managed throughout the peanut moisture removal process. The picking principle employed in the USDA one-row machine has been incorporated into a two-row prototype machine developed at Clemson University. The machine has been field-operated in South Carolina and Virginia.

Development of a microprocessor-based peanut dryer control system - Suffolk, Virginia. Additional software was developed for a microprocessor-based data acquisition system to provide fundamental peanut dryer control functions. The following functions were included: (1) burner control; plenum air temperature high limit and maximum wet bulk depression limit, (2) fan control; ambient air temperature low limit and time-based cycling, and (3) data acquisition; periodically print and punch dryer performance data. The system was interfaced to an existing peanut sample dryer and successfully operated in 1979. This system represents the main step required to give complete computer control and optimization of the peanut drying process. Energy optimization from the control standpoint can now be introduced easily by changing the program.

Technological Objective 2: Develop improved equipment and techniques for farm handling, cleaning, drying, and processing of harvested crops to improve quality and to reduce costs of labor and machinery.

NPS Contact: L. A. Liljedahl

Research Locations:

Tifton, Georgia
E. Lansing, Michigan
Corvallis, Oregon
Wenatchee, Washington

Examples of Recent Progress:

Trace additive incorporation system developed - Tifton, Georgia. A system was designed to incorporate extremely small quantities of dry additives to ground forage in the pellet mill before pelleting. The system included a hopper with a 2.5-cm-diameter bottom feeder screw powered through a variable speed drive which was placed to drop the additive on top of the meal in the feeder screw before it entered the pellet mill mixing chamber. The trace additive incorporation system has been used successfully in a 3-year study of the value of the feeding additive, monensin sodium, at the rate of 33 ppm to 'Coastal' bermudagrass. During the study, calves fed Coastal bermudagrass pellets plus monensin sodium gained 13% faster, consumed 2% less feed per day, and required 12% less feed per unit of gain than control animals. This additive-incorporation system will be useful in further livestock feeding research and may be used in commercial feeding processing plants.

Rock-bin heat storage yields best solar energy use for crop drying - Tifton, Georgia. Drying tests on peanuts and corn were run which compared three systems: solar-heated air with rock storage, solar-heated water with water storage, and conventional LP gas-fired dryers. The air/rock system averaged 70% energy from solar for the peanut tests, 82% for the corn tests. The water storage system averaged 45% energy from solar for the peanut tests, 53% for the corn tests. Further testing will evaluate yearly reliability and long-term costs.

Microwave-vacuum drying process reduces drying energy requirements - Tifton, Georgia. By utilizing an evacuated chamber (20-50 mm pressure) microwave energy at the frequency of 2450 MHz was supplied to heat various crops, and the operating parameters for drying of corn, wheat, peanuts, soybeans, and rice were developed. The drying energy requirement for microwave-vacuum drying of most agricultural crops was only about one-half to two-thirds the energy required for conventional drying.

New fruit bin filler developed - Wenatchee, Washington. A filler was designed, developed, and tested for gently placing apples and pears into a pallet container. The filling principle was used initially on experimental mechanical harvesting equipment. The system was then tested for high-volume application in fruit packing plants, and a prototype unit was used at several industry locations. A commercial version is now being manufactured. The unit has a higher input rate than other commercially available dry fillers and maintains the fruit quality without the extra cost involved with flumes used with the water flotation fillers.

Technological Objective 3: Develop improved equipment and techniques for tilling, planting, transplanting, fertilizing, and cultivating crops to increase production, reduce labor and machinery costs, reduce fossil fuel use, and improve harvesting efficiency.

NPS Contact: L. A. Liljedahl

Research Locations:

Salinas, California
Shafter, California
Belle Glade, Florida
Urbana, Illinois
Beltsville, Maryland
East Lansing, Michigan
Mississippi State, Mississippi
Stoneville, Mississippi
Lubbock, Texas
Temple, Texas
Suffolk, Virginia

Examples of Recent Progress:

Electronic system for singulating small irregularly shaped seeds developed and tested - Salinas, California. A laboratory model seeding device which utilizes digital electronic circuitry was built to singulate small irregularly shaped seeds, such as are common in vegetable crops. Tests conducted in the laboratory with lettuce seed showed that the planter was capable of the accuracy and versatility desired.

Individual row-unit type unpowered soil-incorporating cotton planter developed - Shafter, California. A cotton planting unit which incorporates chemicals in a narrow band adjacent to the row without a power drive system has been developed and field-tested for several years. A third field test was completed by evaluating the effectiveness of the planter as an incorporator and its ability to operate in different soil conditions. The planter design appears to be a distinct improvement over commercial planters for mechanically inserting and covering the cotton seed without compaction. As an herbicide applicator, grass control varied from 85 to 97% and pigweed control from 84 to 94% except in 3 of 60 low-rate plots where no control existed. Cotton stands were not affected.

Lack of fall tillage decreases soybean emergence and yield - Urbana, Illinois. A four-year study in the Midwest of the corn and soybean rotation compared two tillage systems and four row spacings for the soybeans. Emergence of the soybeans was greater in the conventionally-tilled system. Narrow rows with conventional tillage provided the greatest yield advantage of any system tested. Lack of fall tillage following corn resulted in a corn stalk residue cover that significantly lowered soybean emergence in the reduced tillage system with narrow rows. The less than optimum soybean stands did not compete favorably with weeds, and further reduced the yield potential.

No-till planting system satisfactory for peas - Beltsville, Maryland. Peas were planted directly into winter barley with a no-tillage planter. Weed control was not a serious problem in the field so barley control by pre-emergence herbicide was the primary factor affecting yield. Paraquat alone did not provide adequate barley control but paraquat in combination with X-77, pendimethalin, ethalfluralin, and diclofop was satisfactory. Glyphosate also gave complete barley control, but diclofop and acifluorfen were inadequate. None of the herbicide treatments resulted in any noticeable pea injury. There was no residual effect of any pea herbicide treatment on sweet corn planted after pea harvest.

Best no-till legume establishment system for marginal or depleted land identified - Beltsville, Maryland. No-till seedings of red clover and birds-foot trefoil were made in both spring and fall with and without herbicides, insecticides, and fertilizer to determine optimal methods and equipment for legume establishment. Full harvest yields of sod-seeded red clover was more productive than the check. Trefoil was less productive than red clover. Fall was superior to spring seeding for trefoil, whereas there was no difference with red clover. More grass and fewer seeds were present in the banded than in the broadcast paraquat plots. Although stands of both trefoil and red clover were obtained without paraquat when the sward was closely clipped, these stands were inferior to stands that were treated with paraquat to reduce competition.

Satisfactory systems for legume reestablishment on year-round grazing systems for small farms have been determined - Beltsville, Maryland. Orchardgrass-Kentucky bluegrass pastures were sod-seeded with mixtures of (a) alternate rows of red clover and birdsfoot trefoil-white clover; (b) alternate rows of red clover and crownvetch-white clover; or (c) alternate rows of red and white clover, and have been grazed for three grazing seasons. Animal performance and liveweight gain per unit of land were satisfactory and similar for all three mixtures.

Flooding of soils before planting reduced soybean yields - Stoneville, Mississippi. Clay soil plots were flooded for seven weeks in the spring, then drained, before planting four common varieties of soybeans. Yields of all four varieties were significantly lower than the same varieties grown where they had not been flooded, although early vegetative growth was greater.

System developed for multi-cropping and inter-cropping under southeastern small farm conditions - Mississippi State, Mississippi. Equipment has been developed for seeding wheat and clover into standing cotton. Two-year and 3-year crop rotations have been carried out with 40-inch beds with normal tillage and traction practices, and with 80-inch wide beds with reduced tillage and controlled traffic. A 2-year rotation of wheat-soybeans-clover-cotton produced the greatest net return, but a 3-year rotation of corn-wheat-soybean-clover-cotton also returned more than conventional single cropping practices. Use of wide beds and controlled traffic did not improve overall yields or gross returns.

Technological Objective 4: Develop equipment, facilities, and techniques to control or modify crop environment in the field, plant growth chambers, and in greenhouses.

NPS Contact: L. A. Liljedahl

Research Location:

Beltsville, Maryland

Examples of Recent Progress:

Plant response to light and temperature fitted into four categories - Beltsville, Maryland. Plants respond to light and radiation including solar and supplemental lighting depending upon their thermal and spectral sensitivity. Under normal light growing conditions the four classes (with examples) are: 1. Spectrally and thermally insensitive (rose), 2. Spectrally insensitive and thermally sensitive (tomato), 3. Spectrally sensitive and thermally insensitive (lettuce), and 4. Spectrally sensitive and thermally sensitive (chrysanthemum). The thermally sensitive plants thus require relatively high intensities of visible radiation but will not tolerate the thermal radiation associated with these sources. The thermally insensitive plants not only tolerate the thermal radiation associated with these sources, but actually develop more rapidly and flower earlier than plants in environments provided with lower levels of total radiation. Based on tests both in growth chambers and in greenhouses supplemented with energy efficient lamps the measurement of radiation only in the visible region (400-850 nm) was inadequate to explain the difference in plant response.

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Special Research Program (under NRP 20160)

PRODUCTION AND CONTROL OF NARCOTIC PLANTS

This Special Research Program works to affect the production economics of illicit narcotic groups so as to give licit agricultural enterprises a competitive advantage and, secondly, assure that the United States has an adequate and stable supply of raw materials to meet its medical needs for codeine at reasonable cost.

NPS Contact: Quentin Jones

A separate Annual Report was not prepared this year.

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